

**DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY
LUCKNOW**



**Evaluation Scheme & Syllabus
For**

**B.Tech. Third Year
(Biotechnology)**

**On
Choice Based Credit System
(Effective from the Session: 2018-19)**

**DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY
LUCKNOW**

**Study and Evaluation Scheme
B.TECH. BIO-TECHNOLOGY
(Effective from the session: 2018-19)**

3rd Year, 5th Semester

S. No.	Subject Code	Subject Name	Teaching Deptt.	L-T-P	Th/Lab Marks	Sessional		Total	Credit
						Test	Assig/Att.		
1	RAS501	Managerial Economics	Applied Science	3-0-0	70	20	10	100	3
2	RAS502/ RUC501	Sociology/ Cyber Security	Applied Science	3-0-0	70	20	10	100	3
3	RBT-501	Genetic Engineering	Core Department	3-0-0	70	20	10	100	3
4	RBT-502	Fermentation Biotechnology	Core Department	3-1-0	70	20	10	100	4
5	RBT-503	Bioinformatics-I	Core Department	3-0-0	70	20	10	100	3
6	RBT-051-054	Departmental Elective-I	Core Department	3-1-0	70	20	10	100	4
7	RBT-551	Genetic Engineering Lab	Core Department	0-0-2	50		50	100	1
8	RBT-552	Fermentation Biotechnology Lab	Core Department	0-0-2	50		50	100	1
9	RBT-553	Bioinformatics-I Lab	Core Department	0-0-2	50		50	100	1
10	RBT-554	Nano Biotechnology Lab	Core Department	0-0-2	50		50	100	1
	Total							1000	24

Departmental Elective-I

RBT051: Pharmaceutical Biotechnology

RBT052: Nano Biotechnology

RBT053: Biomedical Instrumentation

RBT054: Metabolic Engineering

RBT-501: Genetic Engineering

L	T	P
3	1	0

Unit I (10)

Gene cloning- concept and basic steps; Restriction modification enzymes used in recombinant DNA technology, endonucleases, ligases and other enzymes useful in gene cloning; Vectors: plasmid, bacteriophage and other viral vectors, cosmids, artificial chromosomes, yeast artificial chromosome, Bacterial Artificial Chromosome, Ti plasmid, shuttle vectors, expression vectors; DNA delivery methods; Construction of genomic and cDNA libraries; Techniques for selection, screening and characterization of transformants (hybridization based techniques, expression & interaction based techniques).

Unit II (8)

Concept of PCR; DNA polymerases; primer designing, linkers, adapters, setting up PCR reactions; Various types of PCR; Applications of PCR in disease diagnostics, forensic sciences and genetic engineering.

Unit III (6)

Gene expression in prokaryotes & eukaryotes, Tissue specific promoter, wound inducible promoters, Strong and regulatable promoters, promoter analysis (EMSA and DNA footprinting), gene expression profiling (real time PCR, SAGE, differential display, Microarray); DNA sequencing methods; Molecular markers: RAPD, RFLP, AFLP, SNP; Site directed mutagenesis, gene silencing techniques.

Unit IV (6)

Applications of genetic engineering; Creation of recombinant microorganisms, transgenic plants and animals; cloning of sheep (Dolly) & other mammals; applications in conservation; therapeutic vs. reproductive cloning; ethical issues and the prospects for human cloning; Gene therapy; DNA drugs and vaccines.

Unit V (10)

Basic concepts of cell signaling, Extracellular signal molecule and their receptors, Operation of Signaling molecules over various distances, Cellular response to specific combinations of extracellular signal molecules; Nuclear receptor; Ion channel linked, G-protein mediated receptors, Relay of signal by activated cell surface receptors via intracellular signaling proteins, Intracellular Signaling proteins as molecular switches.

Text books and references

1. T.A Brown (2006). Gene cloning and DNA analysis, WILEY-BLACKWELL
2. Genetic Engineering by Dr Smita Rastogi & Dr Neelak Pathak, Oxford University Press
3. S.B Primrose (2001). Molecular biotechnology. Panima Publishing corporation, 2nd edition
4. Molecular Cloning, A laboratory Manual. Sambrook, J., Fritsch, E.F., Mariatis.3rd edition
5. Genetic Engineering, Priciples & Practice by Sandhya Mitra, McGraw Hill Education.

RBT-502: Fermentation Biotechnology

L T P
3 1 0

Unit I **8**

Introduction to fermentation technology: Interaction between Bio-chemical engineering, Microbiology and Biochemistry. History and development of fermentation industry: Introduction to submerged and solid state fermentation, Microbial culture selection for fermentation processes. Primary and Secondary metabolites.

Unit II **6**

Raw material availability, quality, processes and pretreatment of raw materials. Major alcoholic raw materials. Applications of the nonconventional raw materials (cellulosic material and hydrocarbons).

Unit III **8**

Different regulatory mechanisms involved in controlling the catabolic and anabolic processes of microbes. Induction, nutritional repression, carbon catabolite repression, crabtree effect, feedback inhibition and feedback repression.

Unit IV **10**

Creation/procedures for developing mutants of the desired microbes with the stable capacity of producing desired metabolites. Isolation and preservation of different types of mutants induction resistant, feedback inhibition resistant. Concept for over production of primary and secondary metabolites.

Unit V **8**

Details of the process, parameters and materials -for the industrial manufacture of Antibiotics (β -lactum), Solvents (acetone) Amino acid (Lysine), Organic acids (Citric acid), Alcohols (Ethanol), Ind. Enzymes (Protease/Amylase) and Biopharmaceuticals (Insulin/Interferon etc.)- Microbial Transformations, Microbial leaching.

Text books and References:

1. Murray Moo -Young , Comprehensive Biotechnology, Vol. 1 & III-latest ed.
 2. Microbes & Fermentation, A. Lel and Kotlers Richard J. Mickey, Oriffin Publication
 3. Industrial Fermentations- Leland, N. Y. Chemical Publishers.
 4. Prescott and Dunn's- Industrial Microbiology, 4 th, ed.
 5. Biotechnology Series, Rehm, Reed & Weinheim, Verlag-Chemie.
 6. Biochemical Engg., Aiba, Humphrey & Miller, Academic Press.
- Fermentations & Enzyme technology, Wang & Humphrey, Wiley & Inter Scienceiotechnology

RBT-503: Bioinformatics-I

L	T	P
3	1	0
		10

Unit I

Introduction to Bioinformatics; Biological databases: Nucleotide databases, Protein databases, Specialized databases; Laboratory data submission and data retrieval; Various file formats for biomolecular sequences: Genbank, EMBL, Fasta, GCG, msf, nbrf-pir etc.; Basic concepts of sequence similarity: identity and homology, definitions of homologues, orthologues, paralogues; Sequence patterns and profiles: Basic concept and definition of sequence patterns, motifs, domains and profiles; various types of pattern representations viz. consensus, regular expression (prosite-type) and profiles.

Unit II

08

Sequence Alignment: Pairwise sequence alignments: Dot matrix for sequence alignment, Dynamic programming for Local and Global alignment; Multiple sequence alignment: progressive method and Iterative method; Applications of pairwise and multiple sequence alignment; Tools for multiple sequence alignment: CLUSTALW and Pileup (Algorithmic concepts).

Unit III

10

Scoring Matrices: Basic concept of a scoring matrix, Similarity and distance matrix, Substitution matrices: Matrices for nucleic acid and proteins sequences, PAM and BLOSUM series, principles based on which these matrices are derived; Sequence-based database searches: Need of sequence based database search, BLAST and FASTA algorithms, Various versions of basic BLAST and FASTA, Advance version of BLAST: PHI-BLAST and profile-based database searches using PSIBLAST.

Unit IV

06

Phylogenetics: Phylogeny and concepts in molecular evolution; nature of data used in taxonomy and phylogeny; definition and description of Phylogenetic trees and various types of trees; Different methods of Phylogenetic tree construction: UPGMA and Fitch-Margoliash Algorithm; case studies in phylogenetic sequence analysis.

Unit V

08

Protein structure prediction: Secondary structure prediction (Statistical method: Chou Fasman and GOR method, Neural Network and Nearest neighbor method) and Tertiary structures prediction (Homology Modeling); Structure visualization methods (RASMOL, CHIME etc.); Protein Structure alignment and analysis. Application of bioinformatics in drug discovery and drug designing.

Text books and References

1. D.W.Mount; Bioinformatics- Sequence and genome analysis; Cold Spring Harbour Lab

- press.
2. B.N.Mishra; Bioinformatics: Concept and application, Pearson Education (in press)
 3. O' Reilly; Developing Bioinformatics computer skills- 1st Indian edition, SPD publication.
 4. Anthony J.F. Griffiths et al; An introduction to genetic analysis, 1st Ed.
 5. Michael Starkey and Ramnath Elaswarapu; Genomics protocols, Humana press.
 6. Stephen Misner & Stephen Kraetz; bioinformatics- Methods and protocols, Humana press.
 7. Lawrence Hunter –Artificial intelligence & Molecular Biology, free on web
 8. Westhead, P; instant notes in bioinformatics; viva publications.
 9. Hooman H Rasid; Bioinformatics basics- Application in biological science and medicine; CRC press.

RBT-011: Pharmaceutical Biotechnology

L	T	P
3	1	0

Unit I (10)

Introduction: Therapeutic categories such as vitamins, laxatives, analgesics, Antibiotics, biologicals, hormones. non-steroidal contraceptives, male contraceptives, Use and applications of female contraceptives, Ethical aspects.

Unit II (8)

Bulk drug manufacturers, Type of reactions in bulk drug manufacture and processes. Special requirement for bulk drug manufacture.

Unit III (12)

Compressed table, wet granulation-dry granulation or slugging-direct compression-tablet presses, coating of tablets, capsules, sustained action dosage forms-parental solution-oral liquids-injections-ointment-topical applications, Preservation, analytical methods and test for various drug and pharmaceuticals, packing-packing techniques, quality management, GMP.

Unit IV (10)

Development of Drug and Pharmaceutical Industry: Therapeutic agents, their use and economics; Regulatory aspects. Drug metabolism: physico-chemical principles, radio activity pharmacokinetic action of drugs in human bodies.

Unit V

Reference Books:

1. Leon Lachman et al Theory and Practice of Industrial Pharmacy, 3 Edition, Lea and Febiger, 1986
2. Remington's Pharmaceutical Science, Mark Publishing and Co.

RBT-012: Nano Biotechnology

L	T	P
3	1	0

UNIT-I **8**

Nanobiotechnology, History, Origin, Fundamental Concepts, Bottom-up versus Top-down approaches, Discussion on Micro and Nanofabrication, Current research, Tool and Techniques, Applications and Implications and Nanofabrication.

UNIT-II **8**

Carbon nanotubes and related structures, Properties, Synthesis, Applications, Metal nano particles types and their synthesis, Application of Gold, Silver and Zinc oxide nanoparticles and Nano chemicals.

UNIT-III **8**

Atomic force microscopy (AFM), Scanning tunneling microscopy (STM), improved nano diagnostic devices, Drug delivery tools through nanotechnology

Unit IV **8**

Synthesis and characterization of different classes of biomedical polymers- their uses in pharmaceutical, cardiovascular ophthalmologic orthopedic areas.

UNIT-V **8**

Micro and Nano biosensor, Bioavailability, Nanoimaging agents, Tumor Targeting through nanotechnology, Quantum dots technology and its applications

TEXT BOOK:

1. Nanotechnology by Mark Ratner and Daniel Ratner, Pearson Education
2. Guozhong Cao ,”*Nanostructures and Nanomaterials , synthesis , properties and applications*” , Imperial College Press ,2004.
3. Hari Singh Nalwa, “*Nanostructured Materials and Nanotechnology*”, Academic Press, 2002
4. Microfabrication and Nanomanufacturing- Mark James Jackson.
5. MEMS and nanotechnology – Based sensors and devices communication, Medical and Aerospace applications - A.R.Jha.
6. Drug Delivery: Engineering Principles for Drug Therapy, M. Salzman,
7. Kazuaki Suzuki, Bruce W.Smith. Microlithography: Science and Technology, CRC Press, ISBN: 978-0824790240.
8. Mihail C. Roco and William Sims Bainbridge, “Nanotechnology: Societal Implications II – Individual Perspectives“, Springer Publishers, Sponsored by National Science Foundation, ISBN-10 1-4020-4658-8.

REFERENCE BOOKS:

1. G.A. Ozin and A.C. Arsenault, "Nanochemistry : A chemical approach to nanomaterials", Royal Society of Chemistry, 2005.
2. T. Pradeep , "*NANO The Essential , understanding Nanoscience and Nanotechnology*". Tata McGraw-Hill Publishing Company Limited , 2007.
3. Charles P.Poole Jr. "*Introduction to Nanotechnology*", John Willey & Sons , 2003.
4. Nanomedicine, Vol. IIA: Biocompatibility by Robert A. Freitas Fabrication of fine pitch gratings by holography, electron beam lithography and nano-imprint lithography (Proceedings Paper) Author(s): Darren Goodchild; Alexei Bogdanov; Simon Wingar; Bill Benyon; Nak
5. Kim; Frank Shepherd. A Three Beam Approach to TEM Preparation Using In-situ Low Voltage Argon Ion Final Milling in a FIBSEM Instrument E L Principe, P Gnauck and P Hoffrogge, Microscopy and Microanalysis (2005), 11: 830-831 Cambridge University Press.
6. Biomedical applications of nanotechnology edited by Vinod Labhasetwar and Diandra L. Leslie – Pelecky.

RBT-013: Biomedical instrumentation

L	T	P
3	0	0

UNIT I

8

History and development of biomedical instrumentation, biometrics, Basic transducer principles: active and passive transducers, transducers for biomedical applications; origin of biopotential and its propagation, sources of bioelectric potentials, electrocardiogram, electroencephalogram, electromyogram and other bioelectric potentials. Biopotential Electrodes: types of electrode surface, needle and microelectrodes, biochemical transducers.

UNIT II

8

The Cardiovascular system, Cardiovascular measurements: electrocardiography, measurement of blood pressure, measurement of blood flow and cardiac output, plethymography, measurement of heart sounds; Patient care and monitoring: elements of intensive care unit, pacemakers and defibrillators, Measurements in the respiratory system: mechanics of breathing, gas exchange and distribution, respiratory therapy equipment.

UNIT III

8

Non-invasive diagnostic instrumentation: Temperature measurements ultrasonic measurements, the nervous system and neuronal communication measurement in nervous systems, Instrumentation for sensory measurements and the study of behaviors, psychophysiological measurements, Biotelemetry.

UNIT IV

8

Instrumentation for the clinical laboratory, Automation of chemical tests, Biomedical instruments for surgery, Haemodialysis machines. X-ray machines and digital radiography.

UNIT V

8

Medical Imaging equipments, the computer in biomedical instrumentation and applications, microprocessors, Electrical safety of medical equipment, physiological effects of electric current.

Recommended books:

1. Biomedical Instrumentation and Measurement by Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer
2. Biomedical Instrumentation: Technology and Applications by Raghbir Singh
3. Medical Instrumentation for Health Care by Leslie Cromwell
4. Analysis and Application of Analog Electronic Circuits to Biomedical Instrumentation by Robert B. Northrop
5. Introduction to Bioinstrumentation: With Biological, Environmental, and Medical Application by Clifford D. Ferris.

RBT-014: Metabolic Engineering

L	T	P
3	1	0

UNIT I**6**

Concept of metabolism, anabolism & catabolism, General Principles of Intermediary Metabolism, Regulation of Pathways, Strategies for Pathway Analysis.

UNIT II**8**

Glycolysis: Electron and ATP Tracking, Regulation of glycolysis; Gluconeogenesis: Reaction basis, Regulation of gluconeogenesis; Pentose Phosphate Pathway: Control of Pentose Phosphate Pathway. The Tricarboxylic Acid Cycle: Discovery of the TCA Cycle, Steps in the TCA Cycle, Stereochemical Aspects of TCA Cycle Reactions, Regulation of TCA Cycle Activity.

UNIT III**8**

Electron Transport and Oxidative Phosphorylation : The Mitochondria Electron - Transport Chain, Oxidative Phosphorylation, Transport of Substrates, Pi, ADP and ATP into and out of Mitochondria, Electron Transport and ATP Synthesis in Bacteria.

UNIT IV**8**

Photosynthetic Processes Involving Light: Photosynthesis, Other Biochemical Processes Involving Light. Metabolism of Fatty Acids: Fatty Acid Degradation, Biosynthesis of Saturated Fatty Acids, Regulation of Fatty Acid Metabolism.

UNIT V**8**

Metabolic Organization and Regulation of metabolism, Signal Transduction, Regulation of Metabolism for the production of Primary and Secondary Metabolites with Case studies, Plasma Membrane: Structure and Transport, Protein Targeting

References:

1. Wang D. I. C., Cooney C. L., Demain A. L., Dunnill P., Humphrey A. E., Lilly M. D., Fermentation and Enzyme Technology, John Wiles and Sons., 1980.
2. Stanbury P. F. and Whitaker A., Principles of Fermentation Technology, Pergamon Press, 1984.
3. Zubay G., Biochemistry, Macmillan Publishers, 1989.
4. Metabolic engineering edited by Sang Yup Lee and Eleftherios T. Papoutsakis

5. Metabolic engineering - Principles and Methodologies by Gregory N. Stephanopoulos, Aristos A. Ariostidou and Jens Nielsen.

RBT-551: Genetic Engineering Lab

L	T	P
0	0	3

1. Estimation of DNA by diphenylamine reaction
2. Determination of RNA by orcinol method
3. To isolate plant DNA using CTAB.
4. Elution of plant DNA fragment from agarose gel
5. To perform restriction digestion of λ DNA
6. Dephosphorylation of restriction enzyme digested vector pUC18.
7. To make bacterial cells competent for transformation
8. To perform transformation of the desired bacterial strain with plasmid DNA
9. SDS-PAGE of proteins under reducing conditions (SDS-PAGE)
10. To perform Southern Hybridization
11. To perform ligation of λ *EcoRI* digest using T₄ DNA ligase

RBT-552: Fermentation Biotechnology Lab

L	T	P
0	0	3

1. Fermentative production of Penicillin Antibiotics using *Penicillium chrysogenum*.
2. To study the induction effect of β -galactosidase enzyme in *E.coli*.
3. Upstream and Downstream of bioprocess for the production of Citric acid by *Aspergillus niger*
4. Citric acid production from whey with glucose as supplementary carbon source by *Aspergillus niger*
5. Microbial production of citric acid by solid state fermentation process.
6. Microbial production of enzymes by (a) solid state and (b) submerged fermentation.
7. Fermentative production of Ethanol using *Saccharomyces cerevisiae*.

8. Wine Fermentation.
9. Microbial production of Biosurfactant using suitable strain.
10. Microbial production of Biopolymer using suitable Strain.
11. Computational Design of Fermentative Process

RBT-553: Bioinformatics-I Lab

L	T	P
0	0	2

1. Get five nucleotide and five protein sequences in FASTA format from NCBI and EMBL.
2. To find out five similar sequences for any nucleotide and protein query sequence using BLAST and FASTA.
3. Access and use of different online nucleotide and protein alignment tools (Pairwise and Multiple sequence alignment).
4. Genes and Exons identification related search for a given genome sequence in order to predict the gene.
5. ORF prediction in the given nucleotide sequence.
6. Secondary structure prediction for given amino acid sequences of a given protein using Chou Fasman, GOR method and Neural Network method.
7. Visualize tertiary structure of any given protein sequence.
8. Carry out the alignment of genomes of given organisms.
9. Predict the homology model of any protein sequence.

Text books and References

1. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins by Andreas D. Baxevanis
2. Structural Bioinformatics by Philip E Bourne, John Wiley & Sons
3. Analytical Tools for DNA, Genes & Genomes: by Arseni Markoff, New Age.

RBT-554: Nanobiotechnology Lab

L	T	P
0	0	2

1. Introduction to nanoscience and nanobiotechnology (Size comparative analysis)
2. Synthesis and characterization of carbon nanotubes from carbon source.
3. Chemical synthesis of silver and gold nanoparticles; UV-Visible absorption of the colloidal solution and estimation of size by curve fitting.
4. Biological synthesis of silver and gold nanoparticles; UV-Visible absorption of the colloidal solution and estimation of size by curve fitting.
5. Metal nanoparticles toxicity estimation in percentage as *in vitro*
6. Metal nanoparticles toxicity estimation as *in vivo*
7. Sol gel synthesis of zinc oxide nanoparticles.
8. Antibacterial activities of silver and zinc nanoparticles, against bacterial cultures performed by standard disc diffusion method.
9. Nature of Interaction between nanoparticles & Bacterial Cell (*E. coli* and *B. subtilis*).
10. Demonstration of nano characterization tools and techniques.

Reference books:

- Nanotubes and Nanowires- CNR Rao and A Govindaraj RCS Publishing
- Drosophila Nanotoxicity Analysis: A Practical Approach – Pankaj Kumar Tyagi (1st Eds.), 2017 New Delhi BIRDS Press.

**DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY
LUCKNOW**

**Study and Evaluation Scheme
B.TECH. BIO-TECHNOLOGY
(Effective from the session: 2018-19)**

3rd Year, 6th Semester

S. No.	Subject Code	Subject Name	Teaching Deptt.	L-T-P	Th/Lab Marks	Sessional		Total	Credit
						Test	Assig/Att		
1	RAS601	Industrial Management	Applied Science	3-0-0	70	20	10	100	3
2	RUC601 / RAS602	Cyber Security/ Sociology	Applied Science	3-0-0	70	20	10	100	3
3	RBT601	Bioprocess Engineering	Core Department	3-0-0	70	20	10	100	3
4	RBT602	Plant Biotechnology	Core Department	3-1-0	70	20	10	100	4
5	RBT603	Bioinformatics-II	Core Department	3-0-0	70	20	10	100	3
6	RBT061-064	Departmental Elective-II	Core Department	3-1-0	70	20	10	100	4
7	RBT651	Bioprocess Engineering Lab	Core Department	0-0-2	50		50	100	1
8	RBT652	Plant Biotechnology Lab	Core Department	0-0-2	50		50	100	1
9	RBT653	Bioinformatics-II Lab	Core Department	0-0-2	50		50	100	1
10	RBT654	Food Biotechnology Lab	Core Department	0-0-2	50		50	100	1
	Total							1000	24

Departmental Elective-II

- RBT-061: Animal Biotechnology
- RBT-062: Biomarker & Diagnostics
- RBT-063: Food Biotechnology
- RBT-064: Entrepreneurship in Biotechnology

RBT-601: Bioprocess Engineering

L	T	P
3	1	0

(8)

Unit I

Media Preparation, Media design and optimization. Microbial growth patterns and kinetics in batch culture, Microbial growth parameters, Environmental conditions affect growth kinetics, Kinetics of thermal death of microorganisms, Heat Generation by microbial growth, Quantitative analysis of microbial growth by direct & indirect methods.

Unit II

(8)

Sterilization: concept and methods. Type of Sterilizations, Batch heat sterilization of liquids, Estimation of sterilizer efficiency, Continuous heat sterilization of liquids, Sterilization of air: Methods & Mechanism, Design of depth filter and estimation of its efficiency. Stoichiometric calculations, Theoretical prediction of yield coefficients, Stoichiometry of growth and product formation, Maximum possible yield, Theoretical oxygen demand, Stoichiometry of single-cell protein synthesis.

Unit III

(8)

Ideal Reactor Operation: Batch, Fed Batch & Continuous operation of mixed bioreactors, Microbial pellet formation, Kinetics and dynamics of pallet formation. Chemostate with immobilized cells, Chemostate with cell recycle, substrate utilization and product formation in bioreactor, Scale up of Bioreactors

Unit IV

(8)

Role of diffusion in Bioprocessing, Convective mass transfer, Gas-liquid mass transfer, Oxygen uptake in cell cultures, Factor affecting cellular oxygen demand, Oxygen transfer in bioreactors, Measurement of volumetric oxygen transfer coefficient, Oxygen transfer in large bioreactor.

Unit V

(8)

Bioreactor control mechanism, Physical, Chemical and Biological environment of bioreactor, Manual control system, Role of physical, chemical & biological sensors, Advanced control strategies viz. PID controllers, Fuzzy logic based controllers and artificial neural network based Controllers. Basic concepts of computer modeling and optimization in bioprocess applications.

Text Books and Reference Books

1. Principles of Microbe and cell cultivation- S. John Pirt, Butterworth Publication.
2. Bioprocess Engineering Principles – P. M. Doran, 5th ed.
3. Hand Book Of Bioengineering- Skalak R & Shu Chien, 4th ed.
4. Biochemical Engg. Bailly & Ollis, Academic Press
5. Introduction to Chemical Engg. Series, MCH Int. Series.
6. Biochemical & Biological Engg. Science, N. Blakebraugh, Academic Press
7. "Principles of fermentation technology" by P F Stanbury and A Whitaker, Pergamon press.
8. "Bioprocess Technology - Kinetics & Reactors" by A Moser, Springer-Verlag.
9. "Biochemical Engineering and Biotechnology Handbook" by B. Atkinson & F. Mavituna, 2nd Ed. Stockton Press.
10. Biochemical Engineering- S. Aiba , A.E. Humphray, University of Tokyo Press.
11. Bioreactor Design & Product Yield, BIOTOL Series
12. Bioreactors in Biotechnology: A Practical approach by Scragg
13. Process Biotechnology Fundamentals by S.N. Mukopadhyay
14. Bioprocess Engineering: Basic Concepts by Shular & Kargi
15. Fermentation Microbiology & Biotechnology by Mansi

RBT-602: Plant Biotechnology

L	T	P
3	1	0
		10

Unit I

Introductory history of plant biotechnology: Laboratory organization; Principles of Plant Tissue Culture. Concepts of totipotency, competency, determinism, explants, inoculums, Acclimatization.. Nutrition of plant cells; Nutrient media: Composition of commonly used nutrient culture media with respect to their contents like inorganic chemicals, organic constituents. An appraisal of different media, selection of media, Sterilisation of the media. Hormones: Auxins, cytokinins, Gibberellins, Abscisic Acid, ethylene etc. Explant preparation and Surface sterilization. Basic procedure for Aseptic Tissue transfer.

UNIT-II

10

Culture of plant materials- explants selection and technique of culturing. Organogenesis, Embryogenesis, Somaclonal variation, germiclonal variation Establishment, growth and maintenance of Callus and cell suspension culture, Methods of sub culturing and transfer of regenerated plants to the field. Tissue and organ culture; Cellular differentiation and regulation of morphogenesis;. Somatic embryogenesis; Control of organogenesis and embryogenesis; Single cell culture

Unit III

8

Haploid production -Androgenesis; Anther and microspore culture; Gynogenesis; Embryo culture and rescue in agricultural and horticultural crops; Protoplast isolation; Culture–regeneration; Somatic hybrid-cybrids; *In vitro* selection of mutants – mutants for salts, disease, cold, drought, herbicide and other stress conditions; Micropropagation: Application of micropropagation in agriculture and forestry . Meristem culture and virus elimination; Shoot tip culture.

Unit IV

8

Improved crop varieties through somaclonal variation in *in vitro* cultures -- Causes- stability and utilization – genetic and epigenetic basis; Establishment of cell lines and evaluation. Application of tissue culture for crop improvement in agriculture, horticulture and forestry. Cryopreservation and slow growth cultures, Freezing and storage, thawing, reculture. Application of plant tissue culture in transgenic plants and production of secondary metabolites and industrial products.

Unit V

8

Genetic transformation using Ti plasmid Manipulation of gene expression in plants; Production of marker free transgenic plants. Developing insect-resistance, disease-resistance, herbicide resistance; stress and senescence tolerance in plants. Genetic manipulation of flower pigmentation, Developing quality of seed storage, Provitamin A, iron proteins in rice, Modification of food plant taste and appearance, yield increase in plants

References:

1. Hudson T Hartmann: Plant Propagation-Principle and Practices
2. Principles of Plant Biotechnology- An Introduction of Genetic Engineering in Plants by S.H. Mantell, J.W. Mathews and R.A. Mckee, Blackwell Scientific Publications.
3. Chopra V L, Sharma R P & Swaminathan M S: Agricultural Biotechnology
4. Hamish A, Collin & Sue Edwards: Plant Cell Culture
5. Razdan M K: An Introduction to Plant Tissue Culture
6. Introduction to Plant Tissue Culture, Bhojwani and Rozdan
7. H.S. Chawla. Plant Biotechnology, Oxford IBH publications

RBT-603: Bioinformatics-II

L	T	P
3	1	0

Unit I [10]

Inference problems and techniques for molecular biology. Overview of key inference problems in biology: Homology identification, Genomic sequence annotation (Genes and ORFs identification), Protein structure prediction (Secondary and Tertiary structure prediction), Protein function prediction, Biological network identification, Next generation sequencing, Microarray data analysis.

Unit II [8]

Basics of RNA Structure prediction and its limitations, Features of RNA Secondary Structure, RNA structure prediction methods: Based on self-complementary regions in RNA sequence, Minimum free energy methods, Suboptimal structure prediction by MFOLD, Prediction based on finding most probable structure and Sequence co-variance method. Application of RNA structure modeling.

Unit III [10]

Machine learning: Decision tree induction, Artificial Neural Networks, Hidden Markov Models, Genetic Algorithms, Simulated Annealing, Support vector machines; The relation between statistics and machine learning; Evaluation of prediction methods: Parametric and Non-parametric tests, cross-validation and empirical significance testing (empirical cycle), Clustering (Hierarchical and K-mean).

Unit IV [6]

Basic concept of Force field in molecular modeling (Potential energy calculation); Overview of key computational simulation techniques: Introduction to simulation, Computer simulation techniques, Types of computer simulation (Continuous, Discrete-event and Hybrid simulation), Differential equation solvers, Parameter estimation, and Sensitivity analysis.

Unit V [8]

Overview of key techniques for the management of large document collections and the biological literature: Document clustering, Information retrieval system; Natural Language Processing: Introduction, Major areas of NLP, Natural language information extraction; Insilico Drug Designing: Major steps in Drug Designing, Ligand and Structure based drug designing, Protein-ligand docking, QSAR Modeling, Pharmacodynamics (Efficacy & Potency) & Pharmacokinetics (ADME), Lipinski's rule of five, Pharmacogenomics.

Text Books & References

1. Computational Methods in Biotechnology – Salzberg S. L. et al., Elsevier Science.
2. D.W.Mount; Bioinformatics- Sequence and genome analysis; Cold Spring Harbour Lab

press.

3. Statistical Methods in Bioinformatics-Evens & Grants, Springer-Verlag, NY.
4. Computational Molecular Biology- Setubal and Meidanis, PWS publishing Co., 1997. 18/ 24
5. Protein Structure Prediction-A Practical Approach, MJE Sternberg, Oxford University Press.
6. Purifying Protein for Proteomics, Richard J. Simpson, I.K. International Pvt. Ltd.

RBT-021: Animal Biotechnology

L	T	P
3	1	0

Unit I

8

Basic cell culture techniques, Types of cell culture media; Ingredients of media; Physiochemical properties; CO₂ and bicarbonates; Buffering; Oxygen; Osmolarity; Temperature; Surface tension and foaming; Balance salt solutions; 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 II

8

Different tissue culture techniques; Types of primary culture; Chicken embryo fibroblast culture; Chicken liver and kidney culture; Secondary culture; Trypsinization; Cell separation; Continuous cell lines; Suspension culture; Organ culture etc.; Behavior of cells in culture conditions: division, growth pattern, metabolism of estimation of cell number; Development of cell lines; Characterization and maintenance of cell lines, stem cells; Cryopreservation; Common cell culture contaminants.

Unit III

8

Cell cloning and selection; Transfection and transformation of cells; Commercial scale production of animal cells, stem cells and their application; Application of animal cell culture for *in vitro* testing of drugs; Testing of toxicity of environmental pollutants in cell culture; Application of cell culture technology in production of human and animal viral vaccines and pharmaceutical proteins.

Unit IV

8

Cell culture reactors; Scale-up in suspension; Scale and complexity; Mixing and aeration; Rotating chambers; Perfused suspension cultures; Fluidized bed reactors for suspension culture; Scale-up in monolayers; Multisurface propagators; Multiarray disks, spirals and tubes; Roller culture; Microcarriers; Perfused monolayer cultures; Membrane perfusion; Hollow fiber perfusion; Matrix perfusion; Microencapsulation; Growth monitoring

Unit V

8

Transgenic animal production; Methods of transgene delivery; Integration of foreign genes and their validation; Gene targeting; Methods and strategies; Improving transgene integration efficiency; Cell lineages and developmental control genes in drosophila and mice; Differentiation of germ layers; Cellular polarity; Stem cell differentiation; Blood cell formation; Fibroblasts and their differentiation; Differentiation of cancerous cells and role of protooncogenes;

Texts/References:

1. B. Hafez and E.S.E Hafez, Reproduction in farm animals, 7th Edition, Wiley Blackwell, 2000
2. G.E. Seidel, Jr. and S.M. Seidel, Training manual for embryo transfer in cattle (FAO Animal Production and Health Paper-77), 1st Edition, W.D. Hoard and sons FAO, 1991
3. I. Gordon, Laboratory production of cattle embryos, 2nd edition, CAB International, 2003.
4. Louis-Marie Houdebine, Transgenic Animals: Generation and Use 5th Edition, CRC Press, 1997.

RBT-022: Biomarker & Diagnostics

L	T	P
3	1	0

Unit – I**12**

Introduction to Molecular Diagnostics: History of diagnostics, Age of molecular diagnostics, Significance, Scope, Rise of diagnostic industry in Indian and global scenario, **Cellular Complexity:** Cell components, Cell Differentiation, Cellular communication – endocrine signalling, paracrine signalling and autocrine signalling, contact dependent and synaptic communications, Intracellular networks – transport pathways, signalling pathways and metabolic networks. Eukaryotic Cell Control System and their Components, Intracellular cell cycle control system, Extracellular Cell Cycle Control System, Regulation of Cell Growth and Apoptosis, Genetic and epigenetic factors that regulate these pathways, their abnormalities that alter the pathways and cellular functions.

Unit – II**08**

Molecular Oncology Mitochondrial disorders: Cancer – Benign and Malignant neoplasms, multifactorial disposition, Cancer pathogenesis, positive and negative mediators of neoplastic development, Proto-oncogenes, Oncogenes and Tumor suppressors. Allele loss and loss of Heterozygosity. Mitochondrial inheritance, Mitochondrial myopathy, lactic acidosis, MELAS, LHONs, identity testing.

Unit – III**06**

Biomarkers in disease diagnostics: FDA definition of disease markers, Role of markers in Disease diagnosis. Approaches and methods in the identification of disease markers, predictive value, diagnostic value, emerging blood markers for sepsis, tumour & cancer markers, markers in inflammation and diagnosis of cytoskeletal disorders.

Unit – IV**10**

Chromosomes, Human disorders, and Cytogenetic analysis : Structure, types and organization; Chromosome organization, Euchromatin and heterochromatin and Histone modifications. Chromosome banding and nomenclature; Nomenclature and functional significances of chromosome bands. GC and AT rich isochores. Structural and Numerical aberrations and its consequences. X-chromosome dosage compensation and inactivation mechanism. Sex determination and Y chromosome; function, and diseases. Uniparental disomy, Genomic Imprinting and disorders. FISH, CGH, Flow cytometry techniques and clinical diagnostics.

Unit – V**10**

Genomic instability, Chromosome mapping & Genome plasticity: Common fragile sites and methods of induction, Heritable fragile sites and FXS. Genomic Instability, mechanism and diseases. Trinucleotide Repeats; Mechanism of expansion and triplet repeats and related disorders. Genetic linkage maps, Relation to the probability of recombination, Pedigree analysis with genetic markers and overview of human genome project.

References and text books:

1. Molecular biology of the cell. Bruce Alberts, 6th Edition
2. Principles of tissue engineering. Robert Lanza. Elsevier Publications.
3. Introduction to Tissue engineering, applications and challenges. Ravi Birla. Wiley Publications.
4. Molecular Cell Biology: Darnell J, Lodish H and Baltimore D
5. Cell and Molecular Biology: De Robertis EDP and De Robertis EMF
6. Animal cell culture: Ian Freshney
7. An introduction to Human Molecular Genetics by Pasternak et al., John Wiley & Sons
8. Human Chromosomes by Miller & Tharman, Springer Publishing Company,
9. Molecular Biology of the cell by Alberts et al., Garland Press
10. Genes IX, by Lewin B, Pearson India
11. Cell and Molecular Biology by De Robertis and De Robertis, Lipincott & Wilkins
12. Genome III by Brown TA, Garland Press
13. Elements of medical Genetics by Turnpenny and Ellard, Churchill Livingstone

RBT-023: Food Biotechnology

L	T	P
3	1	0

Unit-I**8**

History of Microorganisms in food: Historical Developments. Role and significance of microorganisms in foods. Intrinsic and Extrinsic parameters of foods that affect microbial growth. Basic principles of the equipment involved in the commercially important food processing methods and unit operations.

Unit-II**10**

Microorganisms in food: spoilage of fresh meats and poultry, processed meats, seafood's, fruits and vegetables. Fermented food products, Medical foods, Probiotics and health benefits of fermented milk and foods products. Dehydrated Foods, Enteral Nutrient Solutions (Medical Foods), Single-Cell Protein. Starter cultures, Production process of cheeses, beer, wine and distilled spirits. Process of Brewing, malting, mashing, primary & secondary fermentation. Problems in food industry: catabolic repression, High gravity brewing, B-glucan problem, getting rid of diacetyl.

Unit-III**8**

Determining Microorganisms and/or their Products in Foods: Microbiological Examination of surfaces, Air Sampling, Metabolically Injured Organisms. Enumeration and Detection of Food-borne Organisms. Bioassay and related Methods. Common Food borne diseases. Nutritional boosts and flavor enhancers: Emerging processing and preservation technologies for milk and dairy products.

Unit-IV**8**

Food Preservation: Food preservation by various methods especially Irradiation, Characteristics of radiations in food preservation, principles underlying the destruction of microorganisms by Irradiation. Application of radiations in food (processing for irradiation). Radappertization, Radicidation, and Radurization of Foods. Effect of Irradiation on Food quality and storage ability. Miscellaneous Food Preservation Methods: High- Pressure Processing, Pulsed Electric Fields, Aseptic Packaging, Manothermosonication (Thermo-ultrasonication).

Unit-V**6**

Indicators of Food Safety and Quality: Indicators of Food microbial quality, product quality and food safety. Fecal Indicator Organisms, Predictive Microbiology/Microbial Modeling. The Hazard Analysis Critical Control Point System (HACCP System), Microbiological Criteria. Food borne intoxicants and mycotoxins.

Text / Reference Books:

1. Frazier, W.S. and Weshoff, D.C., 1988. Food Microbiology, 4th Edn., McGraw Hill Book Co., New York.
2. Mann & Trusswell, 2007. Essentials of human nutrition. 3rd edition. Oxford University Press.
3. Jay, J.M., 1987. Modern Food Microbiology, CBS Publications, New Delhi.
4. Lindsay, 1988. Applied Science Biotechnology. Challenges for the flavour and Food Industry. Willis Elsevier.
5. Roger, A., Gordon, B. and John, T., 1989. Food Biotechnology.

RBT-024: Entrepreneurship in Biotechnology

L	T	P
3	1	0

Unit-I**8**

Entrepreneur - Meaning of Entrepreneur, Evolution of the Concept, Functions of an Entrepreneur, Types of Entrepreneur, Development of Entrepreneurship steps in entrepreneurial process, Biotech Entrepreneurship in India, Identification of Business Opportunities, Qualities, skills and attributes that successful biotech entrepreneurs possess. Case studies of successful and unsuccessful bio-entrepreneurs

Unit-II**8**

Business development in biotechnology - Factors affecting biotech business: (finance, infrastructure, equipment, manpower, resources, project location, end product, quality issues, etc) Basic principles and practices of management - Definition, concepts and application; Organization types, coordination, control and decision making in management

Unit-III**8**

Core concept of Market: Identification and evaluation of market potential of various bio-entrepreneur sectors. Marketing, Marketing research- concept and techniques, Considerations in establishment of biotechnological start-up - Different models of biotechnological start-ups. The

budget for a biotechnological start-up company. Seed capital raising for a biotechnological start-up company

Unit-IV

8

Role of government and schemes, financial institutions in fostering Bioentrepreneurship, Skills in bio-entrepreneurship-Personality and attitude, Organizational behavior, Leadership, Principles of effective communication Body language, public speaking, presentations, business proposal writing.

Unit-V

8

Biotechnology: emerging industries with examples from Transgenic, Environmental biotechnology, New drug development, DNA chip technology, Stem cell research, Tissue engineering. Contract Research Organization, marketing consultancy, bio-learning module. Ethics and IPR in biotech-Industries - Fundamentals of ethics in business, Ethical dilemmas in biotech industry, IPR- Introduction, Forms of IPR.

RBT-651: Bioprocess Engineering Lab

L	T	P
0	0	3

1. Determine the growth patterns and specific growth rate of *E.coli*
2. Determine the effect of peptone concentration on *E.coli*. growth
3. Determination of specific thermal death rate constant (k_d) for *E.Coli*
4. Determine the effects of temperature & pH on *Pseodomonas putida*
5. Upstream and Downstream of bioprocess for the production of Citric acid by *Aspergillus niger*
6. Citric acid production from whey with glucose as supplementary carbon source by *Aspergillus niger*
7. Upstream and Downstream of bioprocess for the production of α -amylase by *Aspergillus nudulans*
8. Estimation of volumetric liquid mass transfer coefficient (K_La) using sodium sulphite method.
9. Preparation of immobilized enzymes & cells and evaluation of kinetic parameters.
10. Computational Design of Fermentative Process for l-Lysine production

RBT-652: Plant Biotechnology Lab

L T P
0 0 3

1. Preparation of Stocks solution for plant tissue culture media.
2. Preparation of MS/B5 medium (semi-solid) and sterilization.
3. Explant selection, preparation and surface sterilization.
4. To learn culturing, sub culturing and maintenance using selected explants.
5. Initiation of *in vitro* cultures through axillary bud induction
6. Initiation of callus cultures from different explants.
7. Preparation of artificial seed/synthetic seed for conservation of germplasm
8. Extraction of DNA/RNA from plants and its estimation.
9. Isolation and characterization of plant secondary metabolites from selected medicinal plants.
10. Extraction of proteins from plants and its estimation

RBT-653: Bioinformatics-II Lab

L T P
0 0 3

1. Identification of Distantly related homologous sequences of a given query protein sequence using PSI-BLAST.
2. Construct Phylogenetic tree of five evolutionary related protein/nucleotide sequences.
3. Prediction of secondary structure of RNA using any web server.
4. Construction and analysis of Ramachandran Plot using any suitable web server.
5. Align two homologous protein structure and calculation the RMSD for the superposition result.
6. Comparative assessment of best available tools for genome annotation.
7. Construction of restriction maps for various vectors used in genetic engineering using tool “NEBcutter”.
8. Primer Design: Construct primers for the given DNA sequence using any suitable web based tool.
9. Generate 2D QSAR model of a set of legend descriptor data using any web based tool.

Text books and References

1. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins by Andreas D. Baxevanis
2. Structural Bioinformatics by Philip E Bourne, John Wiley & Sons
3. Analytical Tools for DNA, Genes & Genomes: by Arseni Markoff, New Age

RBT-654: Food Biotechnology Lab

L	T	P
0	0	3

1. Isolation and Characterization of food fermenting organism from idli batter.
2. Estimation of ascorbic acid from given food sample by titrimetric method.
3. Analysis of mycotoxin (Aflatoxin) in fungus contaminated food material.
4. Microscopic examination of Food/Milk by breed method.
5. Estimation of lactose from milk.
6. Quality characterization of pasteurized milk by MBRT method.
7. To judge efficiency of pasteurization of milk by Phosphatase test.
8. Detection of microbial count in Milk by SPC method.
9. Determination of Minimum Inhibitory Concentration (MIC) of Antibiotic.