BHARATHIDASAN UNIVERSITY, TIRUCHIRAPPALLI – 620 024.

M.Sc. Biotechnology - Course Structure under CBCS

(applicable to the candidates admitted from the academic year 2008-2009 onwards)

Semester	Course	Course Title	Ins. Hrs / Week	Credit	Exam Hrs	Marks		Total
						Int.	Extn.	
I	Core Course – I (CC)	Biochemistry	6	5	3	25	75	100
	Core Course – II (CC)	Cell & Molecular Biology	6	5	3	25	75	100
	Core Course – III (CC)	Microbiology	5	5	3	25	75	100
	Core Course – IV (CC)	Practical covering Core Courses I, II & III	8	6	3	40	60	100
	Elective Course – I (CC)	Any one from the list	5	5	3	25	75	100
		Total	**30**	**26**				**500**
II	Core Course – V (CC)	Recombinant Technology	6	5	3	25	75	100
	Core Course – VI (CC)	Animal Biotechnology	6	5	3	25	75	100
	Core Course – VII (CC)	Immunotechnology	5	5	3	25	75	100
	Core Course – VIII (CC)	Practical covering the Core Course V, VI & VII	8	5	3	40	60	100
	Elective – II	Enzymology	5	5	3	25	75	100
		Total	**30**	**25**				**500**
III	Core Course – IX (CC)	Plant Biotechnology	5	5	3	25	75	100
	Core Course – X (CC)	Environmental Biotechnology	4	4	3	25	75	100
	Core Course – XI (CC)	Bioprocess Technology	4	4	3	25	75	100
	Core Course – XII (CC)	Practical covering the core courses IX, X & XI	7	4	3	40	60	100
	Elective – III	Any one from the list	5	5	3	25	75	100
	Elective – IV	Any one from the list	5	5	3	25	75	100
		Total	**30**	**27**				**600**
IV	Project Work	Dissertation=80 Marks [2 reviews –20+20=40 marks Report Valuation = 40 marks] Viva = 20 Marks	-	12	-	-	-	100
		Total	**30**	**12**				**100**
		Grand Total	**120**	**90**				**1700**

List of Electives:

Elective Course I

1. Biostatistics
2. Biophysics

Elective Course II

1. Enzymology

Elective Course III

1. Nano Biotechnology
2. Molecular Modeling & Drug Designing

Elective Course IV

1. Genomics and Proteomics
2. Biosafety & Patent rights

Note:

Core Courses include Theory, Practicals & Project

No. of Courses	14 - 17
Credit per Course	4 - 5
Total Credits	70

Elective Courses

(Major based / Non Major / Internship)

No. of Courses	4 – 5
Credit per Course	4 – 6
Total Credits	20

	Internal	External
Theory	25	75
Practicals	40	60

Project

Dissertation	80 Marks	[2 reviews – 20+20	=	40 marks
		Report Valuation	=	40 marks]
Viva	20 Marks			20 marks

Passing Minimum in a Subject

CIA	40%	Aggregate 50%
UE	40%	

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CORE COURSE I – BIOCHEMISTRY

Unit I

Biomolecules – chemical composition and bonding, properties of water, acids, gases and buffer – Carbohydrates – Structure and classification of moon di and polysaccharides, Glycolysis – Kreb's cycle – Gluconeogenesis – HMP pathway

Unit II

Protein – Classification and Properties – four levels of protein structure & conformations, Ramachandran Plot, Structural categories of proteins. Relationship between structure and function, Properties, Bio synthesis, Properties and Metabolism of amino acids.

Unit III

Lipids – Classification – Structure – Properties – Lipid metabolism – Oxidation – Fatty acid and cholesterol Biosynthesis – Glyoxalate cycle, Vitamins – Classification, Derivatives – Secondary metabolites from plants – Functions, Hormones – Types, functions and disorders.

Unit IV

Enzymes – Nomenclature, Classification, Properties, Structure – function relationship of enzymes, Extradition, purification and assay methods of enzymes, Enzyme turnover, Enzyme specificity – enzyme – substrate complex, Factors affecting enzyme action – Metals & cofactors – Proximity, orientation – distortion or strain, Mechanism of enzyme action: chymotrypsin, DNA polymerase, Lysozyme and carboxy petidate. Catalytic RNA

Unit V

Kinetics of enzyme – catalyzed reactions – One substrate and two substrate kinetics, steady-state kinetics – Multisubstrate kinetics – Michaelis – Menten, Line Weaver, burke, Ping=pong, Dixon plot, Enzyme inhibition – type of inhibition, Competitive, no competitive and uncompetitive kinetics. Introduction to enzyme regulation, allosteric enzymes and their significance & cooperative interactions, Activation of enzyme , coenzyme their role and regeneration, Isozymes-lactate dehydro genase. Multi enzyme system: Pyruvate dehydro genase – Polygenic nature, Immobilized enzymes, Application of enzymes in various fields. Enzyme engineering, Enzyme therapy.

Text Book:

1. Stryer.L. (2003) Biochemistry, V. Edition. W.H. Freeman & Co. NY

Reference Book:

1. Michael Cox., David. L. Nelson, (2004) Lehninger, Principles of Biochemistry, Kalyani Publishers, New Delhi.
2. Geofrey L. Zubay, William W. Passon, Dennis L. Vance, (1988), Principles of Biochemistry, IV edition, W. M. C. Brown Publishers, Australia
3. Murray, R.K. A. Grannor, D.K. Mayes, P.A. and Rodwell V. W. (2000) Harper's Biochemistry, McGraw Hill Pvt. Ltd., New Delhi
4. Sober, (2002), Handbook of Biochemistry selected Data for Molecular Biology, II. Edition
5. Arthur M. Lest, (2002), Introduction to Protein Architecture, The Structural Biology of Proteins, Oxford University Press
6. Gregory A. Petsko, Dagmar Ringe, (2003) Protein structure and function (Printers in Biology) Siauer Associates
7. Nicholes C. Price and Lewis Stevens, (2001), Fundamentals of Enzymology, The cell and molecular Biology of catalytic proteins, Oxford University Press.
8. Allan Fershi, (1984), Enzyme structure and mechanism. 2 Rev. Ed. Edition W.H. Freeman & Co. Ltd., USA
9. Trevor Palmer, (1985), Understanding Enzymes, 2 Rev. Ed., Edition Ellis, Horwood
10. K.J. Llaider and Bunting P.S. (1973) The chemical kinetics of Enzyme action, 2 Rev, Ed. Edition, Oxford University Press, London
11. Dixon and Webb, (1964) Enzymes, Longman
12. Trehan. K. (1994) Introduction to Biotechnology, Niley Eastern, New Delhi

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CORE COURSE II – CELL AND MOLECULAR BIOLOGY

Unit I

Introduction to cell concept – Components of a cell – Molecular organization and functions of cell membranes and organelles. Cytoskeleton and its role in cell organization and motility – Cellular energy transactions in mitochondria – Protein sorting – Vesicular traffic in secretion (endoplasmic reticulum through Golgi to lysosome; from plasma membranes via endosomes). Organization of nucleus – cell division – cell cycle – mitosis and meiosis

Unit II

DNA structure – types, Sequence organization of prokaryotic and eukaryotic DNA, DNA modification in specialized chromosomes, Mitochondrial and Chloroplast DNA, DNA replication: Types of DNA replication. Enzymes of DNA replication, Denaturation – Renaturation kinetics, Types of DNA mutations – Detection of mutations. DNA repair

mechanisms, RNA binding proteins, Ribonucleoprotein – complexes and functions, RNA – protein recognition and interactions.

Unit III

Transcription: Structure of a transcriptional unit – Regulatory signal elements: promoter, hI.h motifs, Post transcriptional modification of RNAs, mRNA and coding sequence, Transcription factors, Genetic code, Properties and Wobble hypothesis. Translation, ribosomes and tRNAs. Mechanism and regulation of protein synthesis. Post Translational modification of proteins, inhibitors of protein syntheis, Non-coding RNAs: structure and function, RNA interference: siRNA and miRNAs.

Unit IV

Concept of gene: Genetic fine structure –cistron, muton and recon – exons and introns. Gene Regulation in Prokaryotes: Types of gene regulation, Operon concept – Lac Trp and Ara operons – Gene regulation in eukaryotes – Down stream regulation. DNA re-arrangement: Expression of immunoglobulin gene, antibody diversity. Insertional elements and Transposons – Structural organization and transposition, Plant, Bacterial and Animal Transposons – Classification, Structure, Overlapping genes.. Homologous recombination of genes – Holiday junction – Rec. A and other recombinases

Unit V

Cell signaling: hormones and growth factors, hormone receptors and signal transduction. Cell differentiation: cortical differentiation, Nuclear differentiation, tumorigenesis – theories regarding tumor formation aging theories – cellular, systems, pace maker, Biological clock and Mutation theory, The transformed cancer cell – oncogenes. Cell Senescence and Programmed Cell Death – Apoptosis and necrosis. Genetic pathways for PCD Anti- and – pro – apoptotic proteins

Text Book:

1. Freifelder. D. (2003) – Essentials of molecular Biology – fourth edition, Jones and Bartlett Publications Inc.

Reference Books:

2. Lewin.B. (2007) – Genes IX, Jones and Bartlett Publishers
3. Turner, P.C., Mclennan, A.D. Bates, A.D. (2005) – Instant notes Molecular Biology – III Edition, Routledge, UK

4. Watson, J.D. (1987) – Molecular Biology of Gene – The Benjamin / Cummings Publishing Company Inc., California
5. Darnell, J.E., Lodish, H, and Baltimore, D. (2000) – Molecular Cell Biology, Fourth Edition, W.H. Freeman and Company, New York.
6. Stanley. R. Maloy. John.E. Cronan., David Freifelder (1998), Microbial Genetics, II edition, Narosa Publishing House, Madras
7. Strickberger (1996), Genetics, Prentice Hall of Inida Pvt. Ltd., New Delhi
8. Brown. T.A. (2006), Genomes 3, Garland Science Publications
9. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff. Keith Roberts, Peter Walter, (2002), Molecular Biology of the Cell, IV edition, Garland Publishing, New York
10. Ldish, Harvey, Arnold, Matsudaira, Paul, Kaiser, Chris. A,. Krieger, Monty Scott, Matther P. Zipuruky, Lawrence, Darnell, James (2004), Molecular Cell Biology, W.H. Freeman & Company
11. Anthony J.F. Griffiths, (2000), An introduction to Genetic Analysis, W.H. Freeman
12. Paul. G. Young. (2003), Exploring Genomics, W.H. Freeman
13. Geoffrey M. Cooper, Robert E. Hausman, (2007). The Cell – A Molecular Approach, Sinauer Associates, Inc.,

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CORE COURSE III – MICROBIOLOGY

Unit I

Discovery of Microbes – contribution of various scientists and Development of Microbiology in twentieth century, Classification and characteristic features of Micro organisms(eubacteria, archae, fungi, algae, protozoa and viruses) – Concept of tasa, species, strain, nomenclature and Bergey's manual, Classification of bacteria bases on morphology (shape and flagella), staining reaction, nutrition and extreme environment). Bacterial taxonomy – New approach. Importance and Scope of Microbial technology.

Unit II

Bacterial respiration – aerobic and anaerobic, bacterial photosynthesis and reproduction – asexual and sexual, genetics. Bacterial growth and nutritional requirements, Growth curve, measurement of growth, types of media and preparation of ordinary and special media – methods of preservation and storage of microbes. Culture of viruses. Current methods of microbial identification

Unit III

Antimicrobial agents – Physical and chemical, Antibiotics (each with one example) affecting cell membrane, nucleic acid synthesis, protein synthesis and metabolism, Mode of action – Kinds of side effects – Antifungal and antiviral drugs, Mechanisms of drug resistance, Bioactive natural products (anti-bacterial, anti-fungal, anti-viral) from macroalgae, marine bacteria, dinoflagellates etc.

Unit IV

Biofertilizers – Mechanism of nitrogen fixation and its uses. Bioinsecticides Mycoinsecticides – advantages and mode of action – Bacillus thuringiensis, Baculo viruses, NPV- Biodegradation of xenobiotics, Bio leaching –principle and method – advantages and chemical reaction, Biodetoriation, Bioremediation, Biosurfactants, Bioventing, Biospraying, Phytoremediation, Microbes in petroleum extraction. Applying of microbial biotechnology in sewage and waste and water treatment.

Unit V

Microbial fermentation- Bread, Beer, Wine, Cheese, Vinegar, fermented vegetables, SCP, Alcohol, Acetic acid, fermented Milk and other products – Spoilage microbes and means of controlling the (Physical and Chemical means).

Production of useful products – Antibiotics, Amino acids, vitamins, solvents, vaccines, enzymes, extremozymes from extremophiles – its biotechnological application, Bioenergy, biopolymer and bioplastics production.

Text Book:

1. Glazer and Nikaido, (2007), Microbial Biotechnology, II edition, Cambridge University Press

Reference Books:

2. Alexander M. (1977) Introduction to Soil Microbiology, John Wiley & Sons, New York
3. Ronald M. Atlas, Richard Bartha R., (2004), Microbial Ecology – Fundamentals and applications, Pearson education Limited
4. Pelzer M.J. Jr., Chan. E.C.S. and Kreig N.R. (1993), Microbiology, McGraw Hill Inc. New York
5. Salle A.J. (1999), Fundamental Principles of Bacteriology, fifth edition Tata McGraw – Hill Publishing Company Limited, New York.
6. Adams, Martin, R. Moss., Maurice O. (2004) Food Microbiology, Third edition, Royal Society of Chemistry, Cambridge
7. Frazier WC. And Wean hoff DC., (1998), Food Microbiology, Tata McGraw Hill Publishing Company Limited, New Delhi
8. Baily, J.E..and Ollis, D.F. (1986), Biochemical Engineering Fundamentals, Mc Graw Hill, New York
9. Balasubramanian, D. and Bryce, C.F.A. Jeyaraman, K. Dharmalingam K. Green (2004) Concepts in Biotechnology, COSTED-IBN, University Press, Hyderabad
10. Flickinger M.C. & Drew S.W. (1999) Encyclopedia of Bioprocess Technology – Fermentation Biocatalysis and Bioseperation, (Volumes I – V), John Wiley and Sons , Inc., New York
11. Stanbury P.F. & Whitaker. A. and S.J. Hall (2003), Principles of Fermentation Technology, Butterworth – Heineman, New Delhi
12. Jacquelyn G. Black, (2008), Microbiology Principles & Explorations, Seventh Edition
13. Brenner, D.J. Kreig, N.R. Staley, J.T., (eds.) (2005), Bergey's manual of systematic bacteriology, Vol.II edition, New York, Springer
14. P.S. Bisen, (1994) Frontiers in Microbial Technology, CBS Publishers, Delhi
15. Gerard. J. Tortora, Berdell R. Funke, Christian L. Case, (2006), Microbiology: An introduction, ninth edition, Benjamin Cummings Publications

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CORE COURSE IV – PRACTICALS [Covering the Core Courses I, II & III]

General Instruction

Safety and Good Lab Practical

Safety care and precaution in handling hazardous chemical and disposal of waste
Material safety data sheer, standard units to express concentrations
Biochemical calculation and storage of solution
Storage of general chemical, toxic chemical, organic solvents, fine and labile chemical and biological material, blood and serum

CELL BIOLOGY

1. Isolation of genomic DNA from different sources, human check cells, cauliflowers.
2. Isolation of mitochondria
3. Isolation of Chloroplast
4. RNA isolation from yeast cells
5. Quality and quantity checking of DNA and RNA by UV spectrophotometer
6. Isolation of chromosomal DNA from *E-Coli, Bacillus lichemiformis*

MICROBIOLOGY

1. Preparation of solid and liquid culture media, pure culture techniques, pour plate, spread plate and streaking
2. Microscopic observation, staining and identification of bacteria, fungi and algae – straining techniques – simple and gram
3. Motility test

BIOCHEMISTRY

1. Reaction of carbohydrates: glucose, fructose, lactose and sucrose
2. Qualitative test for amino acid, lipids
3. Estimation of protein by – Lowry method, Bradford method
4. Estimation of serum cholesterol by zak's method
5. Estimation of glucose by Ortho-toluidine method, total sugars by Anthrone method
6. Determination of glycine (Sorensen formal titration), amino acid by ninhydrin method
7. Titrimetric determination of sugars by benedict's method
8. Quantitative enzyme assay
9. Determination and optimization of physical factors affecting enzyme activity
10. Determination of Kinetic constants for enzyme – Kent, Vmax and Km

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ELECTIVE COURSE I – BIOSTATISTICS

Scope: This course targets students knowledgeable in instrumental methods of analysis and thus can generate data. It aims to empower such students in the statistical analysis of data, interpretation of results for writing report / thesis / research dissertation. The paper provides hand on experience with model sums extending the acquired skill to use and apply statistical soft-wares like **COSTAT, SPSS & STATISTICA**

Unit I

Research: Definition – Stage in the execution of research – thesis and paper writing – MS – Journal format – proof reading – gallery proof correction: symbols, Paper presentation: Oral and Posters – Facing the viva voce, Communication skills for effective presentation – Power point preparation

Unit II

Sources of information: Seminal papers, journals, reviews, books, monographs, bibliography, Standard of research journals: paid and unpaid journals, peer reviewed, Quality indices of journals: Impact factor-citation index, Information retrieval, Achieves, databases, Search engines: Goggle, Pubmed, Online database library

Unit III

Biometry: Measures of dispersion: Universe, delimiting the population-mean, Random and stratified random sampling-variables (Definition): qualitative (scaling method), quantitative, continuous, discontinuous – Distinction between Parametric and non parametric methods, mode & median – Model sums : Calculation of mean, SD , SE, CV.

Unit IV

Basics of normal, binomial and Poisson Distribution – Null and alternate hypotheses, type I and II errors, testing significance – use of statistical tables and levels of significance, Statistical tools; Model sums – students 't', Chi-Square (Mendel's ration testing), contingency table – confidence intervals single mean.

Unit V

Statistical tools (continued): ANOVA: One way, two way, MANOVA, multiple range tests; Dunnet, Duncan, Tukey, Bivariate relationship: types of Correlation & regression – significance and confidence intervals of r and b – fitting regression line-predicted & observed Y – partitioning explained & unexplained variation in regression. Model sums: Regression, Correlation, one way ANOVA with Duncan's test.

REFERENCES:

1. Davis, G.B. & Parker, C.A. 1997, Writing the doctoral dissertation, Barron's Educational series, 2nd edition, pp 160: ISSBN: 0812098005
2. Duncary, P. 2003, Authoring a Ph.D. Theis
3. Snedecor, G.W. and Cochran, W.G. 1978, Statistical methods, Oxford and IBH Publishing House, Pvt. Ltd., New Delhi
4. Sokal, R.r. and Rohlf. F.J. 1981, Biometry, Freeman W.H. New york
5. Zar, J.H. 1996, Biostatistical Analysis, Prentice Hall, Upper Saddle River, New Jersey, USA

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ELECTIVE COURSE I – BIOPHYSICS

Unit I - Atomic Structure

Historical background upto Bhor model. Significance of second and third postulates of Bohr's model. Derivation of radius and energy value. Quantization of levels. Using Rydburg's constant, Atomic spectaera is signature of the element. Bhor – Sommerfeld model. Vector atom model. Quantum numbers, Selection rules. Pauli's exclullsion principle. Emission spectra with respect to Na atoms to understand selection rules.

Unit II – Spectroscopy

Definition, Electromagnetic wave. Electromagnetic spectrum. Applications of each region of electromagnetic spectrum for spectroscopy. Introduction to molecular energy levels. Excitation, Absorption, Emission, Rational spectra. Energy levels of rigid diatomic molecules. Vibrational and rotational spectra. Energy levels of diatomic vibration molecules. Rotational vibrational Spectroscopy – IR spectroscopy. Principle construction and working of IR spectrometer. Application of IR Spectroscopy to

biomolecules. Electron spectroscopy. UV – visible spectroscopy. Principle, construction and working of colorimeter, Spectrophotometer, Flurometer. Application to biomolecules (Proteins, DNA, HB, Chlorophyll)

Unit III – Radioactivity

Nucleus, Properties. Nuclear forces. Nuclear models (liquid drop and shell model). Radioactive nucleus. Revision of nuclear radiation and their properties – alpha, beta and gamma. Half life – physical and biological.

Handling and standardization of alpha and beata emitting isotopes. Radioimmunoassay. Radiopharmaceuticals and its uptakes. Production of radionuclide. Measurement of radiation – Dosimetry and detectors

Principle, construction and working open and batch dosimeter, GM counter, Scintillation counter (solid and liquid)

Unit IV – Thermodynamics as applied to biological systems

Enthalpy, Entropy, Free energy, Gibb's free energy (G). Helmholtz free energy (A). Chemical potential. Half cell potential. Redox potential. Structure and bioenergetics of mitochondria and chloroplast.

Thermoregulation

Thermometric properties and types of thermometers (clinical, thermocouple, bimetallic, platinum resistance, thermistor – thermometers). Body temperature and its regulation.

Unit V – Cell Membrane

Organization of plasma membrane. Mass transport. Diffusion – basics, Passive and active transport. Membrane potential, Nernst equation. Passive electrical properties of cell (capacitane, resistancea). Active electrical properties, Electrical model (equivalent) of cell membrane. Depolarization, Hyper polarization of membrane (neuronal). Generation of action potential. Types of biopotentials. Biopotential measurement instrument.

Reference Books:

1. Perspectives of modern physics – Arthur Beiser (Mc Graw Hill)
2. Nuclear Physics an introduction – S.B. Patel (New Age International)
3. Introduction to atomic spectra – H.E. White (Mc Graw Hill)
4. Text Book of optics and atomic physics – P.P. Khandelwal (Himalaya Publishing House)
5. Molecular cell biology – Ladish, Berk, Matsudara, Kaiser, Krieger, Zipursky, Darnel (W.H. Freeman and Co.)
6. Biophysics – Cotrell (Eastern Economy Edition)
7. Clinical Biophysics – Principles and Techniques – P. Narayana (Bhalani Pub. Mumbai.)
8. Biophysics – Pattabhi and Gautham (Narosa Publishing House)
9. Instrumentation measurements and analysis – Nakara, Choudhari (Tata MC. Graw Hill)
10. Handbook of analytical instruments – R.S. Khandpur (Tata Mc. Graw Hill)
11. Biophysical Chemistry – Upadhyay, Upadhyay and Nath – (Himalaya Pub. House, Delhi)

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II SEMESTER

CORE COURSE V – RECOMBINANT TECHNOLOGY

Unit I

Core techniques in gene manipulation, Cutting and joining of DNA, introduction of DNA into cells

Unit II

Cloning strategies, construction of genomic libraries and rDNA Libraries, Probe construction, recombinant selection and screening, Molecular cloning.

Unit III

Analysis of expression, Analysis of recombinant DNA, sequencing, mutagenesis, altered expresswions and engineering genes, Site-directed mutagenesis

Unit IV

DNA amplification using polymerase chain reaction (PCR), key concepts, Analysis of amplified products, Applications of PCR: Ligase chain reaction, RELF, Rapp, DNA Finger printing

Unit V

Expressions systems and their applications, E, coli., Bacillus streptomyces, Yeast, Baculovirus and animal cells as cloning hosts. Yease shuttle vectors, cosmid, Production of antibodies and Vaccines

Reference Books:

1. Principles of gene manipulation by RN old & S.B. Primrose (1996) Blackwell Scientific Publications
2. DNA cloning I & II by DM Glover & BD. Hames (1995) IRL, Press
3. PCR strategies by MA. Innis, DH, Gelfand & JJ Sninskey (((%), Academic press
4. Diagnostic Molecular Microbiology by D.H. Persing, K T.F. Smith, F.c. Teower and T.J. While. ASM Press 1993
5. Recombinant DNA by Watson JD, Gilman M. Witkowski, Zoller M. (1992), Scientific American Books
6. Recombinant gene expression protocols by Tvan RS (1997) Humana Press.

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CORE COURSE VI – ANIMAL BIOTECHNOLOGY

Unit I Animal Cell, Tissue and Organ Culture

History – Definitions – culture Environment (Substrate and Media) – Techniques for establishing of cell lines – insect cell cultivation – organ and embryo culture – cryop reservation – Valuable products
Artificial insemination – Embry9o transfer – cloning (DOLLY, MOLLy and POLLY) Nuclear transplantation, invitro fertilization technology, Genetic Engineering in animals: Transformation of animal cells – Cloning vectors – expression vectors – animal viral vectors and yeast vectors.

Unit II

Tranger ic-animals: Development and uses (Mice, cattle, Goat, Fish and Sheep) and transgenic pets, Tendered meat production – Transgenic breeding strategies – Molecular farming (products with strategic importance)

Unit III

Pest management: Juvenile hormone analogues – phenomenes and genetic manipulation, biotechnology of silkworms, Transgenic silk production – Baculo viruses vector and foreign gene expression, Biotechnological approach to the production of live feed.

Unit IV

Molecular markers: Use of nucleic acid probes and antibodies: In clinical diagnosis and tissue typing - Mapping of human genome – RFLP and applications – Genetic engineering approaches for the correction of genetic disorders – Human cloning – Animal right activities Blus cross in India – Society for prevention of cruelty against animals – Ethical limits of Animal use – Green peace international – peace and peacekeeping – Human Rights and Responsibilities.

Unit V

Regulating the sue of Biotechnology: Regulating (DNA technology – Regulating food and food ingredients – human gene therapy – initial public concerns – accumulation of defective genes in future generation – future of gene therapy, patenting Biotechnology inventions – patenting multi-cellular organisms – patenting and fundamental research.

References:

1. Harrison, M.S. and Bal, I.R. (1997) General techniques of all culture Cambridge University press.
2. Prasash M. and Arora. C.K. (1998)uu and issue culture, Anmol publication Pvt. Ltd.,
3. Darling D.C. and Morgan S.J. (1994) Animal cells, culture Media, Ltd.m, John Wiley sons.
4. Invitro cultivation of animal cells (1994), I. ed., Butter worth – Heinemann Ltd.

5. B. Ianfreshney 2006 culture of Animal cells & Manual of basic technique, fifth edition, Wiley – liss publication
6. Bernard B. Glick, Jack J. Pastunak – Molecular Biotechnology principles and application of Recombinant – DNA
7. B. Sasidhar (2006) Animal Biotechnology MJP publishers
8. Cooper M.G. & Hausman E.R. "The cell & molecular approach" fourth edition by sinauer associated inc.
9. Duhcy R.C. (2007) Text book of biotechnology S.Chand & Company Ltd.
10. Text Book of Animal Biotechnology P. Bamadess S. Meerarani
11. An introduction to molecular Biology – Bobert C. TAit
12. Recombinant DNA and Biotechnology, Second edition – Helen zreuzer and Adrianne marrey
13. Cedric Grillot, Intomology, second edition
14. B. Mathur & textbook of entomology, first edition
15. Bobert Matheson, entomology, and introductory courses, first edition

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CORE COURSE VII – IMMUNOTECHNOLOGY

Unit I

History, Iymphoid organ and cells: History of Immunology, Edward Jenner, Eli Metchnikoff, Louis Pasteur, Robert Koch; Innate immunity – barriers; acquired immunity-cells involved; humoral and cellular immunity; lymphoid organs-primary & secondary – Hamatopoiesis; immunogens and antigens – characteristics of ideal antigens; classes of antigens, cross reactivity, haptens and adjuvants

Unit II

Antibody and complement: Antibody – isotypes – Domain structure, biological properties, kinetics of antibody response. Primary interaction, secondary interaction; Mechanism of generation of antibody diversity, Classical and alternate pathways.

Unit III

Biology of Iymphocyte, Telt and MHC: Ontogeny of B and T Iymphocytes, TcR: Interacation of TcR with MHC molecules; Thymic selection and T-cell differentiation Role of MHC in immunity, Mechanism of allograft rejection. Cytokines in immunse regulation

Unit IV

Hypersensitivity, autoimmunity and tumor immunology: Immediate hypersensitivity – general characteristics, activation and effector phases, clinical aspects – role of IgE; Clinical aspects of Type II, III and IV Hypersensitivity, Etiology of autoimmune disease

– systemic and organ specific. Tumor antigens types, effector mechanism in tumor immunity, Immunodiagnosis and immunotherapy.

Unit V

Immunotechnology: Principles, methodology and application of LTT, Hybridomatechnology and antibody engineering, ELISA; ELISPOT; RIST; RAST and Immunoblotting; FACSCAN, Immunoflourescence and RIA; Immunoinformatics and vaccine designing: Cloning strategies for vaccine production. T cell cloning and stem cell technology

References:

1. Benjamin E. Coico and G. Ssunskine (2000) Immunology a short course, IV edn. (Chapters 1-13) Wiley – Liss Publication, NY
2. Kuby. J (1997) Immunology, III edn. WH Freeman & Co. NY
3. Goldsby R.A. Kindt T.I. and Osborne B.A. (2000) Kuby Immunology IV edn. WH Freeman & Co. NY.
4. Janeway C.A. Travers P. Wolport M and Capra J.D (1999) Immunology IV edn. Current ?Biology, NY
5. Roitt, I (2000), Essential Immunology, IV edn. Blackwell Sci. NY
6. Brown, F, Chanock, R.M., Lerner R.A. (Editiors) (1986) Vaccines 86; New approaches to Immunization
7. Fathman, C.G. Fitch F.W. (1982) Isolation, Characterization and utilization of T-Iymphocytes clones, Academic Press, London
8. Goding, J.W. (1998) Monoclonal antibodies: Principles and practice, Academic Press, London
9. Roitt, Male and Brostoff (1998) Immunology 4th edn. Pub. Mochy, New York pp 28.14
10. Springer T.A. (Editor) (1985) Hybrodoma technology in Biosciences and Medicine, Plenum Press, New York.

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CORE COURSE VIII
PRACTICAL COVERING THE CORE COURSES V, VI & VII

Recombinant Technology

1. Restriction analysis of plasmid (pBR322,pUC18)
2. Selection methods (Blue white selection,insertional inactivation)
3. primer design and PCR amplification of β(beta)- galactosidase
4. Cloning of PCR product into pBR322
5. Introduction of cloned genes and analysis by SDS – PAGE
6. Southern blotting

7. RFLP Analysis of 18s rRNA of the genome
8. Genetic diversity of Pseudomonas by RAPD
9. Reporter gene assay (GUS/ β(beta)- galactosidase)

Reference Books:

1. A short core courses in bacterial genetics by J.H.Miller (1999) cold spring Harbor Laboratory
2. Methods in Molecular Biology and protein chemistry by Brenda D.spangler2002 John Wiley & sons, Ltd
3. Genome Analysis – A laboratory manual – vol I Analyzing DNA – by Bruce Rirren/Eric. D. Green, 1997 cold spring Harbor Laboratory press
4. Molecular cloning" : A Laboratory manual vol.I – III by Sambrook et al., (1989) cold spring Harbor Laboratory
5. Genetic analysis of Bacteria by Stanley R.Maloy, Valley.J.stewart,1996 cold spring Harbor Laboratory press
6. PCR protocols by John M.S.Barlett, David Stirling 2003,Humana press Inc.
7. RNA Methodologies 2nd Edn by Robert E.Farrel Jr.1996 Academic press Inc
8. Short protocols in Molecular Biology Vol I & II, 5th Edn. By Frederick M.Ausbel,Roger Breut,2002,John Wiley & Sons Inc
9. PCR Strategies by Micheal,A.Immis,David.H.Gelfand, 1995 Academic Press,Inc.,

Immunology Practical

1. Purification of Immunoglobulin from serum
2. Antigen preparation
3. Isolation and Enumeration of B & T Lymphocytes
4. Generation of antibody in mouse
5. Agglutination reaction
6. Single and Double immunodiffusion
7. Conjugation of antibodies with Enzyme
8. ELISA : i) Capture ELISA
   ii) Direct ELISA
9. Western blot
10. Immunoelectrophorosis
11. Rocket immunoelectrophorosis
12. Affinity column and purification of antigen
13. Cell fusion for generation of Hybridoma

Reference Books

1. Immunology by L.M. Roitt, J. Brestoff and D.K. Male (1996)
2. Immunology by J. Kubey (1993) Freeman and company
3. Immuno-biology by Janeway CA and Paul Travers 1994
4. Immunological techniques by D.M. Weir (1992)
5. Immunology by I. Roitt (1960)
6. Current Protocols in Immunology 3rd Volumes, Wiley Publication (1994)

Animal Biotechnology Practical

1. Sterilization of glass and plastic wares for cell culture.
2. Preparation of media.
3. Primer culture technique for chicken embryo fibroblast.
4. Secondary culture of chicken embryo fibroblast.
5. Cultivation of continuous cell lines.
6. Quantification of cells
7. Isolation of lymphocytes and cultivation of lymphocytes
8. Cell fusion for generation of Hybridoma
9. Suspension culture technique
10. Cryopreservation of cell primary cultures and cell lines.

Reference Books

1. R. I. Freshney, Culture of Animal Cells, 5th Edition, Wiley-Liss, 2005.
2. John R.W. Masters, Animal Cell Culture: Practical Approach, 3rd Edition, Oxford, 2000.
3. M. Clynes, Animal Cell Culture Techniques, 1st Edition, Springer, 1998.

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ELECTIVE II – ENZYMOLOGY

Unit I

Classification, nomenclature & general properties, Factors, affecting enzyme action pH, temp, ions, substrate concentration, enzyme concentration, inhibitors, Extraction, assay and purification of enzymes units of activity and kinetics of enzyme catalysed reactions – the transition state.

Unit II

Steady state kinetics – bisubstrate and multisubstrate reaction – enzyme catalysed reaction – different types of inhibitors and activators – Machalies Menton, Lineweaver and Burke equations, Km, Kcat and KI value Enzyme specificity – absolute and rigid specificity, Nucleophilic & electrophilic attack

Unit III

Role of co-enzyme in enzyme catalysis: Co-enzyme regeneration, Mechanism of enzyme action eg., lysozyme, chymotrypsin, DNA polymerase, ribonuclease & LDH, zymogen & enzyme activation, allosteric enzymes & metabolic regulations. Clinical & industrial uses of enzymes.

Unit IV

Techniques of enzyme immobilization & their applications – medical, food, leather, textile and paper industries. A brief account of modification of enzymes (enzyme engineering) and its products through r-DNA technology. Biosensors, Mechanism of light activation of enzymes.

Unit V

Industrial utilization of enzymes, practical aspects of large-scale protein purification, use of soluble enzymes, enzyme reactors, membrane reactors, continuous flow, packed bed reactors, large-scale application of microbial enzymes in food and allied industries. Antibiotics production, medical application of enzymes in reverse glycosidase synthetic reaction. Interesterification of lipids, Enzyme therapy.

Books for Reference:

1. Blazej, A. & Zemek.J. 1987: Interbiotech, 87, Enzyme Technologies, Elsevier
2. Murray Moo – Young 1988 Bioreactor immobilized enzyme and cells. Fundamentals and applications, Elseyler, Applied Science
3. Rehm, H.J. and Reed G. 1988, Biotechnology, Vol 7a, Enzyme Technology, Elsevier
4. Terrance G. Cooper 1977 The tools of Biopchemistry, John Wiley & Son
5. William, b. Jakoby, 1984 Methods in Enzymology, Vol.104, enzyme purification and related techniques.

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CORE COURSE IX: PLANT BIOTECHNOLOGY

UNIT – I

Cell and Tissue Culture in Plants: Tissue culture media (composition and preparation), Callus and suspension culture; Somaclonal variation; Micropropagation; Organogenesis; Somatic embryogenesis; Embryo culture. Artificial seeds. Protoplast fusion and somatic hybridization; cybrids; anther, pollen and ovary culture for production of haploid plants. Cryopreservation and DNA banking for germplasm conservation.
Molecular Breeding: Constructing molecular maps - Molecular tagging of genes/traits - Marker-assisted selection of qualitative and quantitative traits. Molecular Biological Strategies in Lower Plants.

UNIT – II

Plant Genetic Transformation: Gene transfer methods in plants: direct and indirect DNA transfer. Chloroplast transformation and its advantages. Transgene stability and gene silencing.
Application of Plant Transformation: Herbicide resistance: phosphoinothricin, Insect resistance: *Bt* genes, non-*Bt* genes like protease inhibitors. Disease resistance: chitinase, antifungal proteins, thionins, PR proteins; Virus resistance: coat protein mediated, nucleocapsid gene. Nematode resistance. Abiotic stress tolerance: drought and salt. Post-harvest losses: long shelf life of fruits and flowers, use of ACC synthase,polygalacturanase, carbohydrate composition and storage, ADP glucose pyrophosphatase, RNAi and Reverse genetics.

UNIT – III

Plant Metabolic Engineering: Introduction - The concept of secondary metabolites - Historical and current views - Importance of secondary metabolites in medicine and agriculture. -Introduction to various pathways: Polyketoid pathway: The basic structure, Stereochemistry, Chemical synthesis of different intermediates, the biochemical pathway, Carbon flow,Different regulatory points, Intermediate pools and their significance; alkaloids, industrial enzymes, biodegradable plastics, polyhydroxybutyrate, therapeutic proteins, lysosomal enzymes, antibodies, edible vaccines, Phytoremediation. Plant host-insect interactions. *nif* and *nod* genes.

UNIT - IV

Genetic engineering for quality improvement: Protein, lipids, carbohydrates, vitamins & mineral nutrients.
Plants as Bioreactor: Green fluorescent & red fluorescent protein – Plantibody production – plants as tool for recombinant protein production – vaccine product in plants – Bio – farming.
Herbal Biotechnology: Economic value of herbals and herbal drugs. Identification, cultivation and micropropagation of herbals, biotechnological exploitation.

UNIT - V

Forest Biotechnology - Basic concepts, principles and scope of forest biotechnology - Applications of plant tissue culture in forest trees: Shoot tip culture – rapid clonal propagation, production of virus – free plants- artificial seed, production of hybrids & somaclones, germplasm storage & cryopreservation.-Intellectual property protection in forest biotechnology.

Nursery Technology: Vegetative cuttings – selection of cuttings, collection season, treatment of cuttings, rooting medium- planting of cuttings. Hardening of plants – Green houses – mist chamber, shed root, shade house and glass home.

Genetic engineering for biotic stress tolerance: Insects, fungi, bacteria, viruses, weeds. Genetic engineering for abiotic stress: drought, flooding, salt and temperature.

REFERENCES

1. Mantel. S. H, Mathews. J. A, Mickee. R.A. 1985. An Introduction to Genetic Engineering in Plants, Blackwell Scientific Publishers, London.
2. Markx. J.L. 1989. A Revolution on Biotechnology. Cambridge University Press, Cambridge.
3. Dodds J.H. 2004. Plant Genetic Engineering, Cambridge University Press, Cambridge.
4. Grierson and S.V. Convey. 1984. Plant Molecular Biology, Blackie and Son, New York.
5. Bernard R Glick and J.J.Pasternak (Eds).1998.Molecular Biotechnology: Principle and Applications of Recombinant DNA technology, ASM Press, Washington,D.C.
6. Monica A. Hughes.1996. Plant Molecular Genetics, Addison Wesley Longman, England.
7. Pierik, R.L.M. 1987. *In Vitro* Hulture of Higher Plants by. Martinus Nijhoff Publisher, Dordrecht.
8. R.A. Dixon and R.A. Gonzales (Eds).1994. Plant Cell Culture: A Practical Approach. Second edition. Oxford University Press. Oxford.
9. Mantell, S.H and Smith, H. 1983. Plant Biotechnology. Cambridge University Press, UK
10. Chrispeels, M.J.and Sadava, D.F. 2000. Plants, Genes and Agriculture, The American Scientific Publishers, USA.
11. Practical Application of Plant Molecular Biology by R.J. Henry.1997. Chapmans and Hall, UK.
12. Hammond, J. McGarvey, P. and. Yusibov, V. 2000. Plant Biotechnology Springer Verlag, UK
13. Kirsi-Marja Oksman-Caldentey and Wolfgang H. Barz.(Ed.).2002. Plant Biotechnology and Transgenic Plants, Marcel Dekker, Inc. New York.
14. Adrian Slater, Nigel W. Scott and Mark R. Fowler. 2003. Plant Biotechnology (The Genetic Manipulation of Plants), Oxford University press, UK.
15. Gilmartin and Bowler. (Eds). 2002. Molecular Plant Biology: A Practical Approach (Vol. I and II), Oxford University press, UK.

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CORE COURSE X: ENVIRONMENTAL BIOTECHNOLOGY

UNIT – I

Environmental Pollution: An Introduction - Types of pollution, Methods for the measurement of pollution; Global environmental problems: ozone depletion, green house effect and acid rain - Methodology of environmental management – the problem solving approach, its limitations.
Air Pollution and its Control through Biotechnology; Bioremediation of contaminated soils and wastelands.

UNIT – II

Water Pollution and Control: Need for water management, Measurement and sources water pollution.- Biological treatment of industrial effluents -Utilization of aquatic macrophytes, terrestrial plants, fungi, bacteria and cyanobacteria. -Biodegradation of inorganic and organic wastes, lignin, tannin. Bioremediation of oil spills. Microbial remediation of phenolics. metals, sewage nutrients (phosphate and nitrate)- Bio Bioremediation and bioaugmentation. Biosorption and bioleaching. Biotechnological approaches for heavy metal elimination from sewage water and effluents.

UNIT - III

Waste Treatment: Physico-Chemical properties of water - Waste water treatment: physical, chemical and biological treatment processes. Biotechnological approaches for industrial waste water treatment - treatment schemes for waste waters of dairy, distillery, tannery, sugar, and pharmaceutical industries. Bioreactors for waste water treatment.
Biomonitoring: Principle of biomonitoring. Biomonitoring and management for effluent toxicity, heavy metal pollution, thermal and radioactive pollution. - Biomonitoring of water pollutation using algae, bacteria, plankton, macrophytes, invertebrates, fishes (Bioindicators).

UNIT – IV

Solid waste management: - types of solid wastes - Solid waste characteristics. Its impact on environment. Solid waste disposal; land filling, incineration. composting, mushroom farming, vermiculture and biogas production - Processing of sugar factory wastes, residential and municipal wastes, coir wastes and mycostraw wastes. Bioplastics.
Xenobiotics: Biodegradation of xenobiotics compounds, Organisms involved in degradation of xenobiotics: hydrocarbons, substituted hydrocarbons, degradative plasmids, surfactants, pesticides. Biotechnological methods for hazardous waste management.

UNIT – V

Conservation Biotechnology: Biodiversity. Definition and types . Uses and values of Biodiversity- Loss of Biodiversity- Conservation and sustainable management of Biodiversity-. *In situ* (afforestation, social forestry, agro forestry, botanical Gardens,

Zoos, biosphere reserves, national parks sanctuaries, scared groves and Sthalavrikshas) and *Ex situ* (Cryopreservation, gene banks, seed banks, pollen banks, sperms banks, DNA banks, Tissue culture and Biotechnological strategies), ecorestoration, environmental and biodiversity laws, environmental education.

Environmental Management: Environmental Impact Assessment. National environmental policies - pollution control Boards- mass movements on environment- environmental ethics- environmental awareness- mass communication.

References

1. Alan Scragg. 1999. Environmental Biotechnology. Pearson Education Limited, England.
2 Jogdand, S.N. 1995. Environmental Biotechnology. Himalaya Publishing House, Bombay.
3. Technoglous, G., Burton,F.L. and Stensel, H.D. 2004. Wastewater Engineering – Treatment, Disposal and Reuse. Metcalf and Eddy, Inc.,Tata Mc Graw Hill, NewDelhi.
4. De, A.K. 2004. Environmental Chemistry. Wiley Eastern Ltd. NewDelhi.
5. Allsopp, D. and K.J. Seal. 1986. Introduction to Biodeterioration. ELBS/Edward Arnold, London.
6. Athie, D. and C.C. Cerri. 1990. The Use of Macrophytes in Water Pollution Control, Pergamon Press, Oxford.
7. Chin, K.K. and K. Kumarasivam. 1986. Industrial Water Technology Treatment, Resuse and Recycling . Pergamon Press, Oxford.
8. Henze, M. and W. Gujer 1992. Interactions of Wastewater: Biomat and Reactor Configurations in Biological Treatment Plan - Pergamon Press, Oxford.
9. Jenkins, D. and B.H. Olson(Eds). 1989. Water and Wastewater Microbiology. Pergamon Press, Oxford.
10.Fry, F.C., Gadd, G.M. Herbert, R.A. , Jones, C.W., and Watson-Craik,J.A.(Eds.) 1982. Microbial Control of Pollution . Cambridge University Press, New York.
11. McEldowney, Sharon, Hardman, David, J.,and Waite, Stephen. (Eds). 1993 . Pollution, Ecology Biotreatment . Longman Scientific & Technical, Harlow, England.
12. Kaul,T. Nady and Trivedy, R.K.1993. Pollution Control in Distilleries. Enviromedia, Karad, India.
13. Sastry, C.A., Hashim, M.A.,and Agamuthu, P.(Eds.)1995. Waste Treatment Plants . Narosa Publishing House, New Delhi, India.
14. Dart, R.K. and R.J. Stretton, 1994. Microbiological Aspects Pollution Control.Elsevier Pub.Co., Amsterdam:New York.
15. John Cairns and Todd V. Crawford 1990. Integrated Environmental Management . Lewis Publishers Inc., Chelsea, Michigan.
16. Dekruiif, H.A.M. deZwart, P.K. Ray and P.N. Viswanathan. 1988. Manual on Aquatic Ecotoxicology, Allied Publishers Pvt. Ltd., Lucknow, India.
17.Cairns, John., B.R. Niedalehner and David R. Orves. (Eds.). 1992. Predicting Ecosystem Risk, Preinceton Scietific Publishing Co.Princeton, NJ, USA.
18. Matsui, S. 1983. Hazard Assessment and Control of Environmental Contaminants in Water. Pergamon Press, Oxford.
19. Robert Lauwerys and Perrine Hoet. 2001. Industrial Chemical Exposure : Guidelines for Biological Monitoring . CRC Press, Lewi Publishers, Boca Raton, Florida, USA.

20. Holmes, G., Singh, B.R. and Thedore. L. 1993. Handbook of Environmental Management and Technology. John Wiley and Sons, New York.
21. Krishna Iyer, V.R. 1992. Environmental Protection and Legal Diffence. Sterling Publishers, New Delhi.
22. Shukla, S.K. and Srivastava, P. 1997. Pollution Control . Common Wealth Publishers, New Delhi.
23. Howard, S., Peavy,D.R. and Rowe and G.Tchnoglous. 1985. Environmental Engineering. McGraw Hill, New York.
24. Raul Gagliardi and Torkel Alfthan. 1984. Environmental Training. Oxford & IBM Publishing Co., Pvt. Ltd., New Delhi.

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CORE COURSE XI: BIOPROCESS TECHNOLOGY

UNIT - I

Introduction – Scope of Biotechnology in bioprocess engineering. Proteins as enzymes; Michaelis-Menten kinetics; Inhibition; Effect of pH and temperature; Immobilized enzymes: methods, Industrial enzymes.

Media for Industrial Fermentation: Types of media, composition of media – carbon sources, nitrogen sources, vitamins and growth factors, mineral, inducers, precursors and inhibitors.

Recombinant Cell Culture Process – guidelines for choosing host, vector systems.

UNIT- II

Microbial Growth: Isolation, Preservation and Maintenance of Industrial Microorganisms.

Inoculum development: Development of inocula for yeast, bacterial, mycelial and vegetative fungal processes; aseptic inoculation of the fermentor.

Microbial growth kinetics: Factors affecting microbial growth.

Sterilization methods: Moist heat; dry heat, flame, filter, gas (ethylene oxide), Richards' rapid method - HTST (high temperature/short time) treatments – continuous sterilizers and pasteurizers - Sterility, asepsis– medium sterilization, batch sterilization, contiuous sterilization, filter sterilization.

UNIT -III

Bioreactors: Introduction to bioreactors; Batch and Fed-batch bioreactors, Continuous bioreactors; solid state and submerged; aerobic and anaerobic fermentation; mixed microbial populations; immobilization of cells and coimmobilization; immobilized cell reactors; Bioreactor operation; Sterilization; Aeration; Sensors; Instrumentation; Analysis of mixed microbial populations, specialized bioreactors (pulsed, fluidized, photobioreactors etc.,).

Design of Bioreactors: Construction material; Basic components – Agitator, aerator, valves and steam traps,seals, stirrer glands; measurement and control of parameters (on-line and off line sensors) – temperature, flow rate, pressure, pH, DO, gas analysis, control

pathways, computer in controlling; Air-lift, stirred tank, tower, fluidized bed, packed bed, pulsed, photo bioreactors.

UNIT -IV

Production Kinetics: Design for single and multiple reaction - size comparisons of single reactor for single reactions, multiple reactor systems for single reaction, eactions in parallel, in series, and series-parallel reactions of first order. Heterogeneous reactions, kinetics and mechanism of heterogeneous, non catalytic, and catalytic reactions.
Downstream Processing: Biomass removal and disruption: Removal of microbial cells and solid matter; Centrifugation; Sedimentation; Flocculation; Microfiltration; Sonication; Bead mills; Homogenizers; Chemical lysis; Enzymatic lysis; Membrane based purification: Ultrafiltration ; Reverse osmosis; Dialysis ; Diafiltration ; Pervaporation; Perstraction; Adsorption and chromatography: size, charge, shape, hydrophobic interactions, Biological affinity; Process configurations (packed bed, expanded bed, simulated moving beds); Precipitation (Ammonium Sulfate, solvent); Electrophoresis(capillary); Extraction(solvent, aqueous two phase, super critical), Drying and Crystallization.

UNIT -V

Industrial Production of Chemicals: Alcohol (Ethanol), Acids (Citric,) solvents (glycerol), Antibiotics (penicillins, tetracycline), Aminoacids (lysine, glutamic acid), Single Cell Protein (algae/fungi). Use of microbes in mineral beneficiation and oil recovery.
Bioseparations: Biomass removal; Biomass disruption; Membrane-based techniques; Extraction; Adsorption and Chromatography. Industrial Processes and Process economics.

REFERENCES:

1. Nakra BC and Chaudhry KK. 2004. Instrumentation, Measurement and Analysis, II edition Tata McGrawHill Publishing Co. Ltd., New Delhi.
2. Mansi El-Mansi and Charlie Bryce. 2002. Fermentation Microbiology and Biotechnology. Taylor and Francis Ltd., London (Replika Press Pvt. Ltd., Kundli – 131 028)
3. Arnold L. Demain and Julian Davies. (1999). Manual of Industrial Microbiology and Biotechnology, III edition ASM press, Washington DC .
4. Michael Shuler and Fikret Kargi. 2002.Bioprocess Engineering: Basic Concepts, 2nd Edition, Prentice Hall, Englewood Cliffs, NJ,
5. Pauline M. Doran. 1995. Bioprocess engineering principles, 1 Edition, Academic Press,
6. Colin Ratledge and Bjorn Kristiansen. 2001. Basic Biotechnology, 2nd Edition, Cambridge University Press, Cambridge.
7. Roger G. Harrison, Paul W. Todd, Scott R. Rudge and Dometri Petrider (Eds). 2003. Bioseparations Science and Engineering, Oxford University Press, Oxford.
8. Bailey, J.E. and D.F Ollis. 1986. Biochemical Engineering Fundamentals, 2nd ed. McGraw-Hill Chemical Engineering Series, Berkshire, U.K.

9. Aiba. S., Humphrey, A.E.and Millis N.F. 1973. Biochemical Engineering. University of Tokyo Press, Tokyo
10. Aktinson B. 1974. Biochemical Reactors. Pion Ltd., London
11. Bailey, J. D. and Ollis, D.F 1986. Biochemical Engineering Fundamentals. McGrew Hill Book Co., New York.
12. Jackson, A.T . 1991. Process Engineering in Biotechnology. Prentice Hall, Engelwood Cliffs, NJ, USA.
13. Enfors, S. O. and Haggstrom, L.H. 1998. Bioprocess Technology – Fundamentals and Application. KTH, Stockholm
14. Shuler, M.L. (Ed.) 1989. Chemical Engineering Problems in Biotechnology. AIChE (Association of Chemical Engineers), Brookfield, CT, USA.
15. Vieth, W.R. 1994. Bioprocess Engineering – Kinetics, Mass Transport, Reactors and Gene Expression.. John Wiley & Sons, Inc., New York.

CORE COURSE XII: PRACTICALS COVERING CORE COURSES IX, X AND XI

PLANT BIOTECHNOLOGY PRACTICALS

1. Tissue Culture Techniques: Media composition and preparation-sterilization Techniques.
2. Micropropagation through node and shoot tip explants
3. Organ development from cultured tissue
4. Induction of Somatic Embryos
5. Culture of matured embryos and endosperm
6. Initiation and maintenance of callus
7. Measurement of plant cell growth, (PCV, cell number, Wet and Dry Weights)
8. Determination of vascular element formation
9. Seed culture technique; Production of Synthetic seeds
10. Phytochemical analysis of total protein, sugar in cultured tissue
11. Detecting antibacterial secondary metabolite production by cultured tissue
12. Qualitative analysis of secondary metabolites in cultured cells
13. Protoplast isolation and fushion
14. Culture of *Agrobacterium*, plasmid isolation and identification by agarose gel Electrophoresis.
15. Agrobacterium mediated transformation studies, confirmation of trans gene Expression by GUS expression, PCR analysis and blotting techniques
16. Demonstration of RFLP and RAPD in plants.

ENVIRONEMENTAL BIOTECHNOLOGY PRACTICALS

1. Water Analysis: Measurement of Total Solids, Total-dissolved solids, Total-suspended solids, dissolved oxygen, total hardness, chloride, turbidity, nitrite, nitrate, COD, BOD, fluoride and total nitrogen.
2. Air Analysis: Suspended particles, Sio2, oxides of nitrogen, H2S
3. Treatment studies of effluent using aeration techniques.
4. Removal of solids using coagulation technique
5. Microbial assessment of air quality (open plate and air sample)
6. Potability test of water (MPN technique).
7. Degradation of phenols. Colorimetric assay
8. Phosphate, nitrogen and metal removal by microbes
9. Generation of biogas (methane) from wastes- estimation by gas chromatography.
10. Field trip to dairy, food industries, sewage treatment plants.

BIOPROCESS TECHNOLOGY PRACTICALS

1. Growth kinetics- Effect of pH and temperature on growth kinetics (Demonstration)
2. Media formulation - Sterilization of bioreactors.
3. Isolation of industrially important microorganisms (amylase, pectinase, cellulase) for microbial process & maintenance of bacterial & fungal cultures.
4. Determination of thermal death point and thermal death time of microorganisms.
5. Microbial production of citric acid using *Aspergillus niger*.
6. Microbial production of Penicillin, wine and Beer
7. Production of amylase, cellulose, pectinase, wine and beer in a bioreactor.
8. Production and Estimation of Alkaline Phosphatase.
9. Downstream process – purification of any one protein / enzyme from fermented broth.
10. Cell and enzyme immobilization.

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ELECTIVE COURSE III-1: NANOBIOTECHNOLOGY

UNIT - I

Quantum Physics: Forces between atoms and molecules, particles and grain boundaries, surfaces – strong intermolecular forces - Van der Waals and electrostatic forces between surfaces – similarities and differences between intermolecular and interparticle forces – covalent and coulomb interactions – interactions involving polar molecules and polarization – weak intermolecular forces and total intermolecular pair potentials – Forces between solvation, hydration.

Basis of Quantum Physics – De Broglie's concept – Operators – Bra and Ket notation- Physical imperfection of wave function – Normalised and orthogonal wave function - Heisenberg's Uncertainty Principle – Statement and illustrations – Ehrenfest Theorem.

Definition of a nano system -dimensionality and size dependent phenomena; Quantum dots, Nanowires and Nanotubes, 2D films; Nano & mesopores – size dependent variation in Magnetic, electronic transport, reactivity etc.

UNIT- II

Synthesis of Nano Materials: Synthesis and Characterizations of Nanoscale Materials; Strategies for Nano architecture (top down and bottom up approaches), Fabrication Technologies and Characterizations. Self-assembly Systems; Some aspects of Nanofluidics: surfactants, polymers, emulsions and colloids.

Various Nano Preparation Techniques – basic concepts of nanostructured materials – nucleation: surface nucleation growth – grain size distribution – nano particle transport in low density media – vapour nano phase thermodynamics – coagulation of nano particles, determination of grain size – aggregate formation – mass fractal morphologies.- Film deposition methods-Sol-gel processing.

New forms of carbon – types of nanotubes – formation, Characteristics and Applications of nanotubes- Quantum Dots and Wires.Gold Nanoparticles. Nanopores. Applications of NanoMolecules in Biosystems. -Nanoscale Elements for Delivery of Materials into Cells. Peptides Coupled Nanoparticles. DNA Based Artificial Nanostructure .Proteins as Components in Nanodevices-. Nanoparticle synthesis in plants, bacteria, and yeast.

UNIT- III

Characterization of Nano Materials: Electron microscopes & Spectroscopy: scanning electron microscopes – transmission electron microscopes - scanning probe microscopy – atomic force microscopy – scanning tunneling microscope – Scanning Non-linear Dielectric microscopy - Nuclear Magnetic Resonance Spectroscopy- Nuclear Quadrupole Resonance Spectroscopy Mossbauer & Microwave Spectroscopy and Electron Spin Resonance Spectroscopy-IR & Raman Spectroscopy.

Nanoanalytics - quantum dot biolabeling – nanoparticle molecular labels – analysis of biomolecular structure by AFM and molecular pulling-force spectroscopy– biofunctionalized nanoparticles for SERS and SPR-. nano manipulator nano tweezers – XPS – ICP.

UNIT- IV

Nanosensors: Chemical and Molecular Sensors – Displacement and Motion Sensors – Force Nanosensors – Pressure Sensing – Thermal Nanosensors – Electric and Magnetic Sensing – Cellular Bioscanning – Non-invasive Neuroelectric Monitoring – Macrosensing – Acoustic Macrosensing – Electric and Magnetic Macrosensing – Neural Macrosensing.

Nanocarriers for Drug Delivery: Nanoscale Devices for Drug Discovery -Application of Nano-biotechnology in drug Delivery- Needs and Requirements – Nanoparticle Flow: Implications for Drug Delivery – Polymeric Nanoparticles as Drug Carriers and Controlled Release Implant Devices – Micelles for Drug Delivery. Micro-array and Genome Chips. Genetic Vaccines: A Role for Liposomes – Polymer Micelles as Drug Carriers – Recent Advances in Microemulsions as Drug Delivery Vehicles – Lipoproteins as Pharmaceutical Carriers – Solid Lipid Nanoparticles as Drug Carriers.

Nanocapsules – A New Drug Delivery System

Nanocapsules preparation, Characterization and Therapeutic Applications – Dendrimers as Nanoparticulate Drug Carriers – Cells and Cell Ghost as Drug Carriers – Cochleates as Nanoparticular Drug Carriers – Aerosols as Drug Carriers – Magnetic Nanoparticles as Drug Carriers – Nanoparticulate Drug Delivery to the Reticuloendothelial System and to Associated Disorders – Delivery of Nanoparticles to the Cardiovascular System – Nanocarriers for the Vascular Delivery of Drugs to the Lungs – Nanoparticulate Carriers for Drug Delivery to the Brain – Nanoparticles for Targeting Lymphatics – Polymeric Nanoparticles for Delivery in the Gastro-Intestinal Tract – Nanoparticular Carriers for Ocular Drug Delivery – Nanoparticles and Microparticles as Vaccines Adjuvants – Pharmaceutical NanoCarriers in Treatment and Imaging of Infection.

UNIT -V

Nanotechnology and the Cell. Cell Motility: Nano Motors and Cellular Navigation Chemotaxis - Transmembrane Signalling and Related Protein. Nanoscale Artificial Platforms: Lipids in Self-assembly Structures.

Nano-Medicine: Bio-Pharmaceuticals – Implantable Materials – Implantable Devices – Surgical Aids – Diagnostic Tools – Genetic Testing – Imaging – Nanoparticles Probe – Case Analysis – 1) Resiprocytes – Mechanical Artificial Red Cells – 2) Using DNA as a construction medium.

Nanotechnology for Cancer Diagnostics and Treatment: Cancer Biology; Clinical Aspects, Current Approaches and Challenges. Nanotechnology for Cancer Research and Therapy. siRNA. Tumor-targeted Drug Delivery Systems. Nanotechnology for Imaging and Detection.

REFERENCES:

1. Ratner, M. and Ratner, D. 2005.Nanotechnology: A Gentle Introduction to the Next Big idea. Pearson Education, Inc. NJ, USA.
2. Christef M. Niemeyer, C. A. Mirkin.2004. Nanobiotechnology: Concepts, Application and Properties. Wiley – VCH Publishers, New York.
3. Tuan Vo-Dinh. 2007. Nanotechnology in Biology and Medicine: Methods, Devices and Applications. Taylor and Francis Inc., London.
4. Pradeep, T. 2006 NANO.Tata McGraw Publishers, New Delhi, India
5. Jain, K.K. 2006. Nanobiotechnology in Molecular Diagnostics: Current Techniques and Applications. Horizon Biosciences, India.
6. Challa S.S.R. Kumar (Ed). 2006. Biological pharmaceutical Nanomaterial, Wiley-VCH Verlag Gmbh & Co, KgaA. Weinham, Germany.
7. Parag Diwan and Ashish Bharadwaj (Ed.). .2006. Nano Medicines Pentagon Press. ISBN 81-8274-139-4.
8. Vladimir P.Torchilin (Ed.). 2006. Nanoparticulates as Drug Carriers. Imperial College Press, North Eastern University, USA. ISBN 1-86094.

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ELECTIVE COURSE III-2: MOLECULAR MODELING AND DRUG DESIGNING

UNIT- I

Introduction to the concept of molecular modeling, molecular structure and internal energy, applications of molecular graphics, coordinate systems, potential energy surfaces, -local and global energy minima.

Molecular mechanics: general features of molecular mechanics- force field, bond stretching, angle bending, torsional terms, non-bonded interactions; force field parametrisation and transferability; energy minimization: derivative and non-derivative methods, applications of energy minimization.

UNIT -II

Molecular dynamics simulation methods: molecular dynamics using simple models, molecular dynamics with continuous potential-setting up and running a molecular dynamic simulation, constraint dynamics; Monte Carlo simulation of molecules.- Simulation for conformational analysis. *Ab initio*, dft and semi empirical methods.

UNIT- III

Recent advances in drug design methodologies- Biomolecular structure, Structure activity relationship, Pharmacokinetics, Pharmacophoric pattern, ADME Properties, quantitative structure activity relationship, Use of genetic algorithms and principle component analysis in the QSAR equations.

UNIT -IV

Macromolecular modeling- Software tools for modeling bio-molecules. Molecular electrostatic potentials, charge analyses. Protein conformations, folding and mutation through modeling-design of ligands for known macro molecular target sites.
Drug-receptor interaction, classical SAR/QSAR studies and their implications to the 3-D modeler, 2-D and 3-D database searching, pharmacophore identification and novel drug design.

UNIT -V

Molecular docking: Docking-Rigid and Flexible Structure-based drug design for all classes of targets- Theories of enzyme inhibition - Enzyme Inhibition strategies.- Enzyme inhibition as a tool for drug development –Examples.
Finding new drug targets to treat disease- strategies for target identification and lead design- Use of Genomics and Proteomics for understanding diseases at molecular level- - new targets for anti-cancer drugs, Drugs that rescue mutant p53's.

REFERENCES

1. Andrew Leach. 1996. Molecular Modelling: Principles and Applications (2nd Edition), Addison Wesley Longman, Essex, England.
2. Alan Hinchliffe. 2003. Molecular Modelling for Beginners, John-Wiley and Sons New York.
3. Cohen, N. (Ed.).1996. Guide Book on Molecular Modeling in Drug Design, Academic Press, San Diego.
4. Frenkel, D. and B. Smit. 1996. Understanding Molecular Simulations. From Algorithms to Applications. Academic Press, San Diego, California.
5. Rauter, C. and K. Horn. 1984. X-ray crystallography and drug design, Elsevier.
6. Kalos, M. and P. A. Whitlock. 1986. Monte Carlo Methods. John Wiley & Sons, New York,.
7. McCammon, J.A. and S.C. Harvey. 1987. Dynamics of Proteins and Nucleic Acids. Cambridge University Press, Cambridge.
8. Rapaport, . D.C. 2004. The Art of Molecular Dynamics Simulation. Cambridge University Press, Cambridge, England.
9. Shanmughavel, P. 2006. Trends in Bioinformatics**,** Pointer Publishers, Jaipur, India.
10. Hansch, Corwin, Leo, Albert, Hockma, D.H. 1995. Exploring QSAR. American Chemical Society, Washington D.C.

ELECTIVE COURSE IV-1: GENOMICS AND PROTEOMICS

UNIT- I

Genome Structure: Genome sizes- microbial and organelle genomes - Centromeres and telomeres, tandem repeats- dispersed repeats (transposons).
Genome Physical Mapping and Sequencing: Fragmenting the genome, the need for markers - marker sequences (RFLPs, AFLPs, SNPs, etc) - hybridization mapping - mapping without cloning - Basic Sanger sequencing - automated sequencing- sequencing simple genomes - Sequencing large genomes - finalizing sequences – resequencing. Genome project and bioinformatics - www databases for genomes -Phylogenetic Genome mapping - DNA sequence database analysis - Random-shearing- GenBank - Web-based ORF finding, sequence alignment and 3-D matrix tools – Genotator - DNA modeling- EST sequencing strategies, whole genome assembly-Characterization of transcriptome.

UNIT -II

Microarray: DNA Micro array, Protein Micro array Transcriptomics, Applications and advantages of Micro arrays- DNA chips and SAGE technology- Organization of genome projects- human, plant, animal and microbial genome.
Plant Genome and Genomics- An overview, measuring gene activity during plant development; programmed morphogenesis and genome expression profiles; Expressed sequence tags (EST's)- Tools of plant genome analysis- Chloroplast DNA-. Comparative study of plant genomes- rice*, Arabidopsis thaliana.*

UNIT - III

Human Genome Project: Genesis – the Alta summit - Tracking the Genes – Forward Genetics approach, Reverse genetics approach, Human Chromosomes. Important genes associated with each chromosomes - Mendelian and sexlinked traits in human inheritance. Genetic diseases due to defects in autosomal and sex linked genes.Identification of genes Causing genetic diseases, Pedigree analysis, PFLP studies , STR linkage mapping; DNA Profiling/DNA fingerprinting: DNA Markers in disease diagnosis and finger printing: RFLPs, VNTRs, Microsatellites, SNPs, Current Technology for DNA Finger printing;Databases of human genome; Gene cards, Gene larynx and others, Applications of functional genomics: Role of genomics in drug design and in gene discovery, in designing personalized therapies.

UNIT- IV

Proteomics: DNA polymorphisms as expressed in proteomes. Large scale proteomic tools-Identifying proteins in complex mixtures: Protein profiling, quantitative 2DGE, multidimensional chromatography, quantitative mass spectrometry, and analytical protein chips- Computational pattern, recognition of proteomes – protein networks and pathways. Protein domains and folds, using sequences and structures to predict gene function, high throughout structural analysis of protein, structural proteomics- Protein structure prediction by homology modeling- fold recognition- ab initio methods for structure prediction;Methods for comparison of 3D structures of protein; Protein structure

databanks- protein databank, Cambridge small molecular crystal structure databank, internal and external coordinate system.

Unit V

Metabolomics: Significance, methodologies, technical problems, data handling, data Interpretation. Computational protein-protein interactions. RasMol – Swiss PDB viewer. **Phamacogenomics and New Drug Design**. Need for developing new drugs: Procedure followed in drug design; Molecular modification of lead compounds; Prodrug and soft drugs; Physico-chemical parameters in drug design; QSAR; Active site determination of enzymes; Design of enzyme inhibitors.- expression arrays to study drug response; SNP genotyping methods and technology.- Model organisms in pharmacogenetic studies: use of yeast, *C. elegans*, zebrafish and mice in pharmacogenetic studies.

REFERENCES:

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2. Gary zweiger, 2003. Transducing the Genome; Information, Anarchy and Revolution in Biomedical Sciences.. Tata McGraw-Hill Publishers, New Delhi.
3. Howard L McLeod1 and William E Evans. 2001. PHARMACOGENOMICS: Unlocking the Human Genome for Better Drug Therapy. *Annu. Rev. Pharmacol. Toxicol.*41:101–121.
4. Evans W.E. and Relling, M.V. 1999. Pharmacogenomics: translating functional genomics into rational therapeutics. *Science* 286:487
5. Satoskar, R.S., Bhandarkar, S.D and Annapure, S.S. 1999. Pharmacology and Pharmacotherapeutics, Popular Prakashan, Mumbai.
6. Branden, C and J.Troze, 1999. Introduction to Protein Structure. Second Edition.Garland Publishing, New Delhi.
7. Baxevanis, A.D and Ouellette, B.F.F. Eds. 2001. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. Wiley Interscience. New York.
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ELECTIVE COURSE IV-2; BIOSAFETY AND PATENT RIGHTS

UNIT - I

Biosafety: Introduction; biosafety issues in biotechnology-historical background; Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals.

UNIT -II

Biosafety Guidelines: Biosafety guidelines and regulations (National and International) – operation of biosafety guidelines and regulations of Government of India; Definition of GMOs & LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of National Regulations and relevant International Agreements including Cartegana Protocol.

UNIT- III

Introduction to Intellectual Property: Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications-importance of IPR – patentable and non patentables – patenting life – legal protection of biotechnological inventions – world intellectual property rights organization (WIPO).

UNIT- IV

Basics of Patents and Concept of Prior Art: Introduction to Patents; Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; Specifications: Provisional and complete; Forms and fees Invention in context of "prior art"; Patent databases; Searching International Databases; Country-wise patent searches (USPTO, esp@cenet(EPO), PATENTScope(WIPO), IPO, etc.).
Patent Filing Procedures: National & PCT filing procedure; Time frame and cost; Status of the patent applications filed; Precautions while patenting – disclosure/non-disclosure; Financial assistance for patenting - introduction to existing schemes Patent licensing and agreement Patent infringement- meaning, scope, litigation, case studies.

UNIT -V

Agreements and Treaties: History of GATT & TRIPS Agreement; Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty; PCT; Indian Patent Act 1970 & recent amendments.

REFERENCES:

1. M.W. and Schinzinger.R. 2003. Ethics in engineering, Martin III Edition, Tata McGraw-Hill, New Delhi.

2. BAREACT, 2007.Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., New Delhi.
3. Kankanala C. ., 2007. Genetic Patent Law & Strategy, 1st Edition, Manupatra Information Solution Pvt. Ltd. New Delhi.
4. Jose Cibelli, Robert P. lanza, Keith H. S . Campbell. 2002. Michael D.West, Principles of Cloning, Academic Press,London.
5. B.B.Hosetti, B.B. 2002. Glimpses of Biodiversity. Daya, Delhi.
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