BHARATHIDASAN UNIVERSITY, TIRUCHIRAPPALLI – 620 024.

M.Sc. Gene Technology - 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)	Microbiology	6	5	3	25	75	100
	Core Course – II (CC)	Biological Chemistry	6	5	3	25	75	100
	Core Course – III (CC)	Cell & Molecular Biology	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)	Microbial Genetics	6	5	3	25	75	100
	Core Course – VI (CC)	Biomedical Engineering	6	5	3	25	75	100
	Core Course – VII (CC)	rDNA Technology	5	5	3	25	75	100
	Core Course – VIII (CC)	Practical covering the Core Course V & 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)	Gene Manipulation of Microbes, Plants and Animals	5	5	3	25	75	100
	Core Course – X (CC)	Structural and Functional Genomics	4	4	3	25	75	100
	Core Course – XI (CC)	Gene Expression 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 – 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 II– BIOLOGICAL CHEMISTRY

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 III – 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 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

BIOLOGICAL CHEMISTRY

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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OR

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 spectra is signature of the element. Bhor – Sommerfeld model. Vector atom model. Quantum numbers, Selection rules. Pauli's exclusion 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 beta 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 (capacitance, resistance). 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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CORE COURSE V - MICROBIAL GENETICS

UNIT 1

Contribution by Louis Pateur and Koch – Comparison of Prokaryotic and Eukaryotic cells - Whittakar's Five kingdom concept. Ultrastructure of bacteria – cytoplasmic inclusions- nuclear material – Plasmid – types and significance. Bacteriological media – culture of microbes – streak plate and pour plate methods. Growth Rate and Growth cycle of bacteria – Structure and composition of virus – Caspid – Symmetry – Nucleic acids – Envelope – Viriods – Viral replication and replication cycle – cultivation of animals virus by chick embryo technique.

UNIT II

Pathogenic microbes in Air, Water, and Soil (Any 5 important pathogenic microbes and disease caused – list only). Microbes and polluted waters – coliform group- Bacteriological examination of water – test for coliform bacteria in water – bacteriological treatment of waste water – BOD. A brief study ,symptoms of disease, mode of transmission and control of pathogenic organism (*Treponema pallidum, Mycobacterium tuberculosis,* Polio virus and HIV only).Microbial Control – Moist heat sterilization, radiation, phenolic compounds, alcohol, Penicillin and Streptomycin.

UNIT III

Nucleic acid as genetic material – proofs, structure and types. DNA replication and repair – Prokaryotic and Eukaryotic genome – Human genome (outline only) with examples - C value paradox – Molecular basis of mutation – Fine structure of gene – Modern concept , Jumping genes – Transposons – Function of DNA.

UNIT IV

Gene regulation in prokaryotes and eukaryotes - Gene regulation and protein synthesis – Transcription and Translation signal – Inborn errors of metabolism – X,Y and autosomal inheritance – Genetic disorder – Gene therapy – DNA fingerprinting.

TEXT BOOKS:

1. Pelczar, M.J., Chan, E.C.S., and Kerign, N.R., 1986, Microbiology, McGraw Hill New York.
2. Strachan, 1999, Human Molecular Genetics, John Wiley and Sons, Singapore.

REFERENCE BOOKS:

1. Ananthanarayanan, R., and J ayaram Paniker, C.K., 1997, Text Book of Microbilogy, Orient Longman Ltd., New Delhi.

2. Davis, B.D., Dulbecco.R., lisen, H.N. and Ginsberg, H.S., 1986, Microbiology, Harper and Row, New York

3. Gardner, E.J. and Snustad, D.P., 1994, Principles of Genetics, John Wiley and Sons, New york

4. Gupta, P.K., 1997, Genetics, Rastogi publications, Meerut, India

5. Hart, D.L. and Jones E.W., 1998, Genetics – Principles and Analysis, Jones and Bartlett Publishers, London.

6. Klug, W.S. and Cummings, M.R., 1997, Concepts of Genetics, Pretice hall international Inc, USA.

7. Lewin, B., 2000. Genes VII. Oxford University Press Inc., New york.

8. Prescott, L.M., Harley, P.J. and Klein, D.A., 1996, Microbiology, WM>C. Brown Publishers, London.

9. Rai, A., 1985, Methods in cell culture and virology, Allied Publishers, New Delhi.

10. Smith, K.M. and Ritchie, D.N., 1980, Introduction to virology, Chapman and Hall, London.

11. Watson, J.D., 1997, Molecular Biology of gene, W.A. Benjamin Inc., London

12. Weaver, R.F. and Hedrick,P.W., 1997, Genetics, WM.C. Brown Publishers, London.

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CORE COURSE VI - BIOMEDICAL ENGINEERING

UNIT I

Definition of biomaterials, requirements of biomaterials, classification of biomaterials, Comparison of properties of some common biomaterials. Effects of physiological fluid on the properties of biomaterials. Toxicity tests: acute and chronic toxicity studies (in situ implantation, tissue culture, haemolysis, thrombogenic potential test, systemic toxicity, intracutaneous irritation test). viscosity and capillary viscometer, Rheological properties of blood, laminar flow, Couette flow and Hagen-poiseuille equation, turbulent flow, Biotransport process, Fluid flow, Heat transfer, Mass transfer. Unified approach of momentum, flow behavior of Newtonian and Non – Newtonian Fluids, Application of momentum Heat transfer and Mass transfer principles of Biological system with particular emphasis on Human being.

UNIT II

Stainless steel, Co-based alloys, Ti and Ti-based alloys. Importance of stress-corrosion cracking. Orthopedic implants, Dental implants. Artificial implantation - Soft tissue replacement implants: Percutaneous and skin implants, Vascular implants, Heart valve implants-Tailor made composite in medium. Polyolefins, polyamides, acrylic polymers, fluorocarbon polymers, silicon rubbers, acetals. (Classification according to thermosets, thermoplastics and elastomers. Biodegradable polymers for medical purposes, Biopolymers in controlled release systems. Synthetic polymeric membranes and their biological applications.

UNIT III

Definition of bioceramics. Common types of bioceramics: Aluminium oxides, Glass ceramics, Carbons. Bioresorbable and bioactive ceramics. Mechanics of improvement of properties by incorporating different elements. Composite theory of fiber reinforcement (short and long fibers, fibers pull out). Polymers filled with osteogenic fillers (e.g. hydroxyapatite). Host tissue reactions.

UNIT IV

Review of the principles of mechanics, Vector mechanics- Resultant forces of Coplaner & Non-coplaner and Concurrent & non-concurrent forces, parallel force in space, Equilibrium of coplanar forces, Newton's laws of motion, Work and energy, Moment of inertia. Skeletal joints, skeletal muscles, basic considerations, basic assumption and limitations, forces and stresses in human joints, mechanics of the elbow, mechanics of shoulder, mechanics of spinal column, mechanics of hip, mechanics of knee, mechanics of ankle

UNIT V

Bone structure & composition mechanical properties of bone, cortical and cancellous bones, viscoelastic properties, Tissue engineering techniques and application, Application of computer in medicine, Medical imaging technique, Biochip, Biomedical instrumentation, electrodes, transducer, Biosensor, and their characteristics. Biopotential amplifiers. Biotelemetry. Recording of ECG, EEG, EMG, ERG, evoked potential etc. Cardiovascular measurement. Measurement of the respiratory system. Analytical instruments in Biomedical engineering, Oximeter, Spectrophotometer, Colorimeter, Blood gas analyzer, Blood cell counter.

Text book

Introduction to biomedical engineering by J. Ederle, S. Blancand & Bronzino, 2nd edition, Academic press (2003)

Reference Books:

1. W.R.Hendee & E.R.Ritenour, Medical Imaging Physics (3rd eds), Mosbey Year-Book, Inc., 1992.

2. W.R.Hendee & E.R.Ritenour, Medical Physics.
3. Massey and Meredeth, Medical Physics.
4. Plummer, Bio Chemistry - The chemistry of Life, Mc Graw Hill.
5. Kuchel, Bio Chemistry, Schaum Series Mc Graw Hill.
6. Patrick Rcully, Electrical Simulation & Electropathology, Cambridge University press
7. Joseph Bronzino, Biomedical Instrumentation.
8. Khandpur R S, Handbook of Analytical Instrumentation, Tata Mc Graw Hill

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CORE COURSE VII – RECOMBINANT DNA 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 VIII
PRACTICAL COVERING THE CORE COURSES V & VII

rDNA 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.,

Microbial Biotechnology

1. Introduction to bioprocess technology, Parts and design of bioreactors; production of biomass; batch and continuous fed batch fermentation, Scale up recovery
2. Laboratory scale fermentation of antibiotics, immobilization of cells and enzymes
3. Isolation of DNA from Cloning vector-plasmids and phages
4. Extraction of total DNA from plant and animal tissues
5. Isolation of restriction enzymes – demonstration of restriction systems, restriction mapping pulse field electrophoresis

Reference Books:

1. Molecular cloning: A Laboratory manual Vol I-III by Sambrook et al., (1989) – Cold spring Harbor Laboratory press
2. Current protocols in molecular biology vol.I & II by F.M Abubel et al., (1987 John Willey Publishers, New York.)

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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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III SEMESTER
CORE COURSE IX: GENE MANIPULATION OF MICROBES, PLANTS AND ANIMALS

UNIT -I

Genetic engineering – an introduction and scope. Vectors- plasmids, phage vectors, cosmids, phagemids, gateway vectors and artificial chromosomes. Enzymes in gene manipulations, DNA transfer techniques.

UNIT- II

Cloning strategies – construction of genomic libraries – types and methods; cloning in *E.coli*, Bacilli and Yeast. Recombinant system and screening of recombinant clones; Recombinant products –detection; site directed mutagenesis.

UNIT- III

Plant genome organization – plant nuclear genes, chloroplast genes, mitochondrial genes; cytoplasmic male sterility; heterosis and hybrid seed. Plant transformation – *Agrobacterium* – Ti and Ri plasmid vectors; Microprojectile bombardments – Gene gun. Phytochrome mediated functions and light activated genes.

UNIT -IV

Gene manipulation in animals - animal cell culture techniques – transfection and production through cell culture technique – regulatory proteins, blood products, vaccines and hormones, transgenic proteins. Chromosomal manipulation of fish, cryopreservation of gametes and embryos. Transgenic animals- *in vitro* fertilization and embryo transfer.

UNIT- V

Pest management using juvenile hormones analogues, pheromones; Biotechnology of silk worms. Baculo viruses in biocontrol and foreign gene expression. Gene therapy – prospects, methods and applications. Genome projects: human, drosophila, *Coenoharbiditis elegans*; Plant genetic engineering for herbicide resistance, pest resistance and disease resistance. Metabolic engineering of plants. Production of antibodies and pharmaceutically useful proteins in plants.

References

1. Old, R.W and S.B. Primrose. 1996. Principles of Gene Manipulation: An Introduction to Genetic Engineering. Blackwell Scientific Publications, Oxford.

2. Glover, DM. and BD. Hames .1995. DNA Cloning: A Practical Approach.. IRL Press, Oxford.
3. Innis, M.A., D.H. Gelfand and J.J. Sninskey .1995. PCR Strategies.. Academic Press, San Diego.
4. Persing, D.H., K T.F Smith, F.C. Teower and T.J.While. 1993. Diagnostic Molecular Microbiology. ASM Press, Washington D.C.
5. Watson J.D.,Gilman M., Witkowski,J., and Zoller M. 1992. Recombinant DNA. Scientific American Books, New York.
6. Tvan R.S. 1997. Recombinant Gene Expression Protocols. Humana Press Inc., Tokowa.
7. Mantel. S. H, Mathews. J. A, Mickee. R.A. 1985. An Introduction to Genetic Engineering in Plants, Blackwell Scientific Publishers, London.
8. Dodds J.H. 2004. Plant Genetic Engineering, Cambridge University Press, Cambridge.
9. Mantell, S.H and Smith, H. 1983. Plant Biotechnology. Cambridge University Press, UK.
10. Hammond, J., McGarvey, P. and. Yusibov, V. 2000. Plant Biotechnology. Springer Verlag, UK.
11. Kirsi-Marja, Oksman-Caldentey and Wolfgang H. Barz.(Ed.). 2002. Plant Biotechnology and Transgenic Plants, Marcel Dekker, Inc. New York.
12. Adrian Slater, Nigel W. Scott and Mark R. Fowler. 2003. Plant Biotechnology (The Genetic Manipulation of Plants), Oxford University press, UK.
13. Gilmartin and Bowler. (Eds). 2002. Molecular Plant Biology: A Practical Approach (Vol. I and II), Oxford University press, UK.
14. Freshney, E. D.2000. Animal Cell Culture: A practical approach. John Wiley Pub.,New York.
14**.** Mather, J.P. and Barnes, D. (Eds.). 1998. Animal Cell Culture Methods (Methods in Cell Biology. VOL. 57). Academic Press**,** London.
15. Butler, M. (Ed.). 1990. Mammalian Cell Biotechnology- A Practical Approach. Oxford Univ. Press, Oxford.
16. Puller, A. (Ed) .1993. Genetic Engineering of Animals. VCH Publishers, New York.

CORE COURSE X: STRUCTURAL AND FUNCTIONAL GENOMICS

UNIT -I

Structural and functional genomics- definition, historical prospective and strategies. Genome Structure: genome sizes – microbial and organelle genome – genome physical mapping and sequencing – tools in genome analysis; Structural and functional annotations of genes and genomes. An overview of genome projects : human, plant, animal and microbial genomes. Analysis of Human Genome Map repositories: NCBI – Entrez Human genome map viewer, OMIM – Online Mendelian Inheritance in Man. Practical uses of genome maps: Locating genomic regions, Target identification, Arrangement of genes, SNP diagnosis, Positional specific cloning,

UNIT -II

Protein conformation, Ramachandran plot and principle of protein folding. protein structure databanks – internal and external co ordinate system-DNA and Protein Data banks.

Protein structure determination – X ray crystallography, protein crystallization, x ray diffraction. molecular replacement and direct method – atomic co ordinates and electron density maps, analysis and correctness of structure. Protein prediction by homology modeling – fold recognition – ab initio methods.

UNIT- III

Methods for comparison of 3D structures of protein. Conformational energy – Molecular mechanisms and molecular dynamics. simulation of free energy charges – force fields, mixed selection, Structure refinement and structure – function relationship. sequence analysis of protein and nucleic acid – restriction analysis, consensus sequences. Structural analysis and homology modeling.

UNIT - IV

Microarray: protein and DNA, transcriptomics - applications and advantages. Proteomics: DNA Polymorphisms as expressed in proteins; Proteomics tools – 2D gels, Mass spectroscopy, computational pattern – protein network and pathways. Human genome project – Functional genomics, role in drug design and personalized therapies.

UNIT- V

Landmarks of human genome: Morbid anatomy of genome comprising allelic disorders, relation to oncogene, malformation syndrome, specific susceptibility/resistance. maternal-fatal incompatibility, functional attributes and other disorders associated with chromosomes 1-10, 11-22 and sex chromosomes in humans.

REFERENCES:

1. Necia Grant Cooper; (Ed.) 1994.The Human Genome Project; Deciphering the Blueprint of heredity University Science books, CA, USA.
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.
8. Higgins, D and Taylor, W (Eds). 2000. Bioinformatics: Sequence, Structure and Databnks.Oxford University Press, Oxford.

CORE COURSE XI: GENE EXPRESSION TECHNOLOGY

UNIT- I

Gene expression technology – techniques for gene expression measurement - DNA microarray, RT-PCR, SAGE techniques. Whole genome human DNA microarrays (commercially available microarrays). Whole genome spotted cDNA arrays.

UNIT- II

Heterologous gene expression systems. Expression of heterologous proteins in *E.coli*. Design and construction of expression vectors – recognition and mRNA initiation. Trp, Lac, and tac promoters in direct expression of proteins.- T7 RNA polymerase for direct expression of cloned genes. araB expression systems in *E.coli.*

High level translation initiation – two cistron expression system – vector for enhanced translation of foreign genes in *E.coli*. Gene fusion for expression – trpE fushion. Secretion of heterologous gene products.

UNIT- III

Adenoviral vectors for protein expression – adaptation of adenovirus for gene transfer. Adenoviral expression vectors – construction and applications – advantages and disadvantages.

Expression system in yeast – advantages and disadvantages. *Pitchia pastoris* – Mehylotrophic yeast- AOX1 gene. Molecular genetic manipulation of *P. pastoris*.

Construction of expression vectors – pPICZ. Integration of expression vector into host genome.

UNIT- IV

Recombinant protein expression in plants – promoters – constitution, tissue specific, inducible. Expression of recombinant proteins – pathogens and pest resistance. Bioremediation. Products of recombinant protein expression – oils, fiber, biodegradable plastics, starch, heterologous proteins. Antibody/Antigen production in plants. Virus – mediated expression systems.

UNIT- V

Vectors used for expression in mammalian cells. Assembly of enhancers, promoters, and splice signals to control expression of transferred genes. Cytomegalovirus – promoters for expression in mammalian cells – Siridbis virus – transgenic expression in mice – recombinant expression of proteins in milk of transgenic animals. Selection and coamplification of heterologous genes in mammalian cells. Growth of cell lines – optimizing for production of recombinant proteins.

REFERENCES

1. Abelson, J., D. Goeddel, and M.Simon 1990. Gene Expression Technology. Academic Press, London.
2. Fernandez, J.M.and J.P.Hoeffler. 1999. Gene Expression Systems. Academic Press, London.
3. Causton, H.C., Quackenbush and A. Brazma. 2003. A Beginners Guide: Microarray Gene Expression Data Analysis. Blacwell Publishing, U.K.

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

1. Isolation of plasmids and characterization
2. Restriction mapping of chromosomal / plasmid DNA
3. Development of competent cells of E-coli (transformation) & selection of transformants by antibiotic resistance.
4. Transformation by electroporation
5. Size fractionation of DNA / Protein
6. Elution of DNA from Agarose gel – electro elution/blotting.
7. Plasmid curing & demonstration of plasmid – encoded functions.
8. GFP cloning & protein expression study (by SDS PAGE).
9. Lac gene induction.
10. Demonstration of GUS assay in plant cells (calli)
11. Screening of transplants for agrimycin resistance
12. Protoplast fusion in plants.
13. Demonstration of microinjection as a level to develop tangencies using oocytes
14. Isolation and characterization of hsp in plants and animals.
15. Demonstration of RFLP and RAPD in plants.
16. Study of sequence data banks - PIR,Swiss-PROT, UniPROT.- Protein Structure and Classification databases – PDB, SCOP, CATH, FSSP,PDBSUM.- Domain / Motif databases – BLOCKS, PRINTS, SBASE and PFAM.
17. Study of Nucleic acid sequence databanks – GenBank, EMBL nucleotide sequence databank, DDBJ, AIDS virus sequence databank, rRNA data bank, UniGene
18. Gene structure and function prediction (using GenScan, GeneMark)
19. Sequence similarity searching (NCBI BLAST)
20. Protein sequence analysis (ExPASy proteomics tools)
21. Multiple alignment - CLUSTALW
23. Phylogenetic Trees - PHYLIP
24. Build a structure for a given sequence using Homology modeling
25. Evaluation of protein structure by Swiss PDB viewer and by other molecular visualization tools.
26. Calculation of phi – psi angles - Ramachandran plot.

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:

1. Necia Grant Cooper; (Ed.) 1994.The Human Genome Project; Deciphering the blueprint of heredity University Science books, CA, USA.
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.
8. Higgins, D and Taylor, W (Eds). 2000. Bioinformatics: Sequence, Structure and Databnks.Oxford University Press, Oxford.

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.
6. Senthil Kumar Sadhasivam and Mohammed Jaabir M. S. 2008. IPR, Biosafety and Biotechnology Management. Jasen Publications, Tiruchirappalli, India.
7. http://www.cbd.int/biosafety/background.shtml
8. http://web.princeton.edu/sites/ehs/biosafety/biosafetypage/section3.html