M. SC. BIOTECHNOLOGY (National Stream)
CURRICULUM and SYLLABUS

From the academic year 2013 admission onwards

DEPARTMENT OF BIOTECHNOLOGY
UNIVERSITY OF CALICUT
KERALA
Pin-673 635
www.universityofcalicut.info

M. Sc. BIOTECHNOLOGY PROGRAMME

UNIVERSITY OF CALICUT

Syllabus for M.Sc Biotechnology

From the Academic Year 2013 onwards

Eligibility for admission

Candidate with Bachelor's Degree under 10+2+3 pattern of education in physical Biological chemical Veterinary and Fishery Sciences, Pharmacy / Engineering/ Technology, 4 years B.Sc (physician Assistant course) or Medicine (MBBS) or BDS with at least 55% marks of a recognized Indian or foreign university are eligible for admission

Process of Admission

Candidates for admission will be selected on the basis of an All India Combined Entrance test conducted every year by an agency authorized by the Department of Biotechnology, Ministry of Science and Technology, Govt. of India

Course structure

The course is designed on semester and credit basis total of four semester and 93 credits covering two academic years. The course covers 16 papers in theory and Eight in practical. For BT 403JC each student will have to give one seminar of one hour duration on topics of current interest in the field which will be assessed by the departmental faculty. The project work commences in the third semester extending up to the end of fourth semester

Counseling

Each course instructor will be the overall counselor for that course

Evaluation

1. General

a. For theory examinations marks for internal assessment and university examinations will be in the ratio of 1:1 for each paper. Two internal examinations in each paper shall be considered and the average of the two will be the marks for internal assessment. Practical examinations will be in the mode of continuous evaluation. There will be two internal practical examinations during each semester for each paper. All examinations in theory and practical are compulsory. Each practical examination will be evaluated for 45 marks. The total of two will be added to 10 marks allocated for assessment of practical records. Students who fail to get a pass minimum of 40 % in theory or practical internal examination will be given another chance (3^{rd}) to reappear for one additional test in theory or practical examination. The marks of which will be taken into account for averaging in the case of theory or for totaling in the case of practical examination. After evaluation, the answer scripts of internal examination will be given to the students to clear their doubts, if any. Valued scripts shall be maintained in the office till the mark lists are issued

b. For external, supplementary and/or improvement examination the university regulation for other M.Sc courses will be followed

2. Project Evaluation

The project dissertation carries a total of 450 marks (Dissertation work – 400 + Presentation and Viva-voce – 50) and will be evaluated separately by both the internal (normally Guide) and external examiners. The Dissertation shall be submitted at the end of the 4th semester

3. Tabulation of results

a. Marks obtained in each course, internal and external will be entered separately
b. For a pass the student should score a minimum of 40% in each course and 50% in aggregate (theory and practicals) which will be classified as second class. 60% and above will be classified as first class. 75% and above will be classified as distinction

Note: A paper-wise minimum of 40% in each course and 50% aggregate in each in each semester is stipulated for a student to pass his / her examination. If a candidate has scored 50% aggregate but failed to get the paper minimum of 40% in any papers, such candidate shall reappear to the concerned only to get the paper minimum (40%). The minimum marks of 40% stipulate to for a pass in a course is applicable to the practicals also.

Grievance Cell

Students grievances pertaining to the award of internal marks shall be brought to the notice of the teacher concerned. In the case of failure to settle the grievance, the matter shall be placed in a three member Departmental Committee consisting of HOD, Department council Secretary or senior faculty and the concerned Teacher. HD will be the chairman of the committee and the decision of the committee shall be final.

SEMESTER – I

Course code	Hours /week	Credits	COURSE TITLE	MARKS		
				Internal	External	Total
BT101CC	3	3	Cell and Developmental Biology	50	50	100
BT102CC	3	3	Biochemistry	50	50	100
BT103CC	3	3	Microbiology and Industrial Application	50	50	100
BT104CC	3	3	Analytical Techniques	50	50	100
BT105PC	6	3	Lab – 1 Biochemistry	100	–	100
BT106PC	6	3	Lab – 2 Microbiology	100	–	100
BT107JC	2	-	Seminar / Journal club	–	–	–
BT108LC	3	-	Language Communication Skills	–	–	-
TOTAL	**=29**	**=18**		**=400**	**=200**	**=600**

SEMESTER – II

Course code	Hours/ week	Credits	COURSE TITLE	MARKS		
				Internal	External	Total
BT201CC	3	3	Molecular Biology	50	50	100
BT202CC	3	3	Intellectual Property Rights & Biosafety	50	50	100
BT203CC	2	2	Biostatistics and Bioinformatics	50	-	50
BT204CC	3	3	Immunology	50	50	100
BT205CC	3	3	Genetics	50	50	100
BT206PC	6	3	Lab – 3 Molecular Biology	100	–	100
BT207PC	2	2	Lab – 4 Biostatistics and Bioinformatics.	50	–	50
BT208PC	6	3	Lab – 5 Immunotechnology.	100	–	100
BT209JC	2	-	Seminar / Journal club	50	–	50
ELECTIVES Select one elective						
BT210EC	2	3	Microbial Technology	50	-	50
BT211EC			Molecular Virology			
BT212EC			Cancer Genetics			
BT213EC			Pharmacogenomics			
BT214EC			Stem Cell Technology			
BT215EC			Molecular Therapeutics			
BT216EC			Bacteriology			
TOTAL	**32**	**25**		**600**	**200**	**800**

SEMESTER – III

Course code	Hours/ week	Credits	COURSE TITLE	MARKS		
				Internal	External	Total
BT301CC	3	3	Bioprocess Engineering	50	50	100
BT302CC	3	3	Genetic Engineering	50	50	100
BT303CC	2	2	Genomics & proteomics	50	–	50
BT304CC	3	3	Plant Biotechnology	50	50	100
BT305CC	3	3	Immunotechnology	50	50	100
BT306PC	6	3	Lab – 6 Bioprocess Engineering	100	–	100
BT307PC	6	3	Lab – 7 Genetic Engineering	100	–	100
BT308PC	6	3	Lab – 8 Plant Biotechnology	100	–	100
BT310JC	2	-	Seminar / Journal club	–	–	–
BT311DC	-	-	Dissertation proposal presentation	–	–	–
TOTAL	**= 34**	**=26**		**=550**	**=200**	**=750**

SEMESTER – IV

Course code	Hours/ week	Credits	COURSE TITLE	MARKS		
				Internal	External	Total
BT401DC	27	20	Dissertation Work Presentation and Viva Voce	150	150 50	300 50
BT402CC	1	3	Bioentreprenuership	50	–	50
BT403JC	2	1	Seminar / Journal club - Recent Advances in Biotechnology	50	–	50
TOTAL	**= 30**	**24**		**250**	**200**	**450**
GRAND TOTAL		**=93**		**=1800**	**=800**	**2600**

SEMESTER – I

BT101CC Cell and Developmental Biology – 3 credits

Unit – I

Cell Theory & Methods of Study

Microscope and its modifications – Light, phase contrast and interference, Fluorescene, Confocal, Electron (TEM and SEM), Electron tunneling and Atomic Force Microscopy, etc.

Membrane Structure and Function - Molecular model; Composition and dynamics - Transport of ions and macromolecules - Pumps, carriers and channels; Membrane carbohydrates and their significance in cellular recognition

Cell junctions and cell adhesion. Extracellular matrix in animals and cell wall in plants.

Unit II

Organelles

Nucleus – Structure and function - nuclear envelope, lamina and nucleolus, macromolecular transport ; Chromatin organization and packaging, mitochondria – structure, organization of respiratory chain complexes, ATP synthase, Structure- function relationship; mitochondrial genome, Origin and evolution; Chloroplast-Structure-function relationship; Chloroplast DNA and its significance; Chloroplast biogenesis, Origin and evolution.

Unit III

Endo-membrane systems - Endoplasmic Reticulum, Golgi complex, lysosomes – protein trafficking; endo and exocytosis.

Cytoskeleton – microtubules, actin and intermediate filaments , associated proteins (MAPs and actin binding proteins); cell shape and motility; Molecular motors.

Unit IV

General principles of cell signaling – paracrine, synaptic, endocrine, autocrine, combinatorial signaling; signaling molecules, cell surface and intracellular receptor proteins

Cell cycle and its regulation; Apoptosis – intrinsic and extrinsic pathways; Cancer as a microevolutionary process, metastasis, oncogenes and tumour suppressors

Unit V

Cellular Movements and Pattern Formation – morphogenetic movements and shaping of body plan

Laying of body axis planes; Differentiation of germ layers; Cellular polarity; cell memory, cell determination and concept of positional values; Heirarchy of gene action – maternal, segmentation and homeotic gene effects in *Drosophila*; Cell lineages and developmental control genes in *C.elegans.*

Plant development – brief outline on meristem, root-shoot axis, growth regulators, homeotic selector genes taking *Arabidopsis* as an example.

Texts/References

Alberts et al: Molecular Biology of the cell. 5th Edition. Garland Science,New York / UK
Lodish et al; Molecular cell Biology, 4th edition, W.H. Freeman & Company, 2000.
Cell and Molecular Biology – Concepts and Experiments by Gerald Karp. John Wiley and Sons Inc.
Waston Et al. Molecular Biology of the gene, 5th Edition, Pearson Prentice Hall, USA, 2003.
B.M. Turner, Chromatin & Gene regulation, 1st Edition, Wiley-Blackwell, 2002.
Benjamin Lewin, Gene IX , 9th Edition, JHones and Barlett Publishers, 2007.

BT102CC Biochemistry – 3 Credits

Unit – I

Chemical basis of life, Composition of living matter; Water – properties, pH, ionization and hydrophobicity; Emergent properties of biomolecules in water; Biomolecular hierarchy; Macromolecules; Molecular assemblies; structure-function relationships
Amino acids – structure and functional group properties, Peptides and covalent structure of proteins; Elucidation of primary and higher order structures; Evolution of protein structure; structure-function relationships in model proteins like ribonuclease A, myoglobin, hemoglobin, chymotrypsin etc

Unit – II

Enzyme catalysis – general principles of catalysis; Quantitation of enzyme activity and efficiency; Enzyme characterization and Michaelis-Menten kinetics; Enzyme kinetics; Two-substrate kinetics and pre-steady state kinetics; Allosteric enzyme mechanism; Relevance of enzymes in metabolic regulation, activation, inhibition and non-covalent modification; Single substrate enzymes. Enzyme inhibitors and active site determination

Unit – III

Sugars – mono, di, and polysaccharides; Suitability in the context of their different functions – cellular structure, energy storage, signaling; Glycosylation of other biomolecules – glycoproteins and glycolipids.

Unit – IV

Lipids – structure and properties of important members of storage and membrane lipids,lipids as signaling molecules, lipoproteins Lipid metabolism
Nucleosides, nucleotides, nucleic acids – structure, diversity, function and metabolism.

Unit – V

Bioenergetics-basic principles; Equilibia and concept of free energy; Coupled processes; Glycolytic pathway; Kreb's cycle; Oxidative phosphorylation; photosynthesis; logic and integration of central metabolism; entry/exit of various biomolecules from central pathways; principles of metabolic regulation; Regulatory steps; HMP shunt.

Text/References

- V.Voet and J. G.Voet, Biochemistry, 3rd edition, John wiley, New York, 2004.
- A.L. Lehninger, Principles of Biochemistry, 4th edition, W.H. Freeman and Company, 2004.
- L. Stryer, Biochemistry, 5th edition, W.H. Freeman and Company, 2002.

BT103CC Microbiology and Industrial Application - 3 Credits

Unit I

Microbial Growth & Physiology Ultrastructure of Archaea (Methanococcus); Eubacteria (E.coli); Unicellular Eukaryotes (Yeast) and viruses (Bacterial, Plant, Animal and Tumor viruses); Microbial growth: Batch, fed-batch, continuous kinetics, synchronous growth, yield constants, methods of growth estimation, stringent reponse, death of a bacterial cell. Microbial physiology: Physiological adoption and life style of Prokaryotes; Unicellular Eukaryotes and the Extremophiles (with classical example from each group)

Unit II

Microbial Diversity & SystematicsClassical and modern methods and concepts; Domain and Kingdom concepts in classification of microorganisms; Classification of Bacteria according to Bergey's manual; Nucleic acid based Molecular methods for classification and grouping.

Unit III

Microbial Interactions and Infection to humans.

Host-Pathogen interactions; Bacterial human infection S. Typhi, M, tuberculosis, Viruses Bacteriophage, Viral multiplication disease causing viruses and their role in bacterial virulence. HIV, HBV

Unit IV

Microbes and Environment

Role of microorganisms in natural system and artificial system; Influence of Microbes on the Earth's Environment and Inhabitants; Ecological impacts of microbes; Symbiosis

(Nitrogen fixation and ruminant symbiosis); Microbes and Nutrient cycles; Microbial communication system; Quorum sensing; Prebiotics and Probiotics;

Unit V

Industrial Applications

Basic principles in bioprocess technology; media Formulation; Sterilization; Primary and secondary metabolites; screening, strain improvement. Microbial processes-production, optimization, factors affecting down stream processing and recovery; Extracellular enzymes; Biotechnologically important intracellular products; exopolymers; Representative examples of ethanol, organic acids, antibiotics etc.

Texts/References

- Pelczar MJ Jr., Chan ECS and Kreig NR., Microbiology, 5th Edition, Tata Mc Graw Hill, 1993.
- Maloy SR, Cronan JE Jr., and Freifelder D, Microbial Genetics, Jones Bartlett Publishers, Sudhury, Massachusetts, 2006.

- Crueger and A Crueger, (English Ed., TDW Brock); Biotecnology: A Textbook of Industrial Microbiology, Sinaeur Associates, 1990
- G Reed, Prescott and Dunn's, Industrial Microbiology, 4thEdition, CBS Publishers, 1987.
- M.T. Madigan and J.M. Martinko, Biology of Microorganisms, 11th Edition, Pearson Prentice Hall, USA, 2006.

BT104CC Analytical Techniques – 3 Credits

Unit 1

Methods of cell disintegration; Enzyme assays and controls, Detergents and membrane proteins; Dialysis, Ultrafiltration and other membrane techniques

Spectroscopy Techniques UV, visible and Raman Spectroscopy; Theory and application of Circular Dichroism; Fluorescence; MS, NMR,PMR,ESR and Plasma Emission spectroscopy. Microscope and its modifications – Light, phase contrast and interference, Fluorescene, Confocal, Electron (TEM and SEM), Electron tunneling and Atomic Force Microscopy,

Unit II

Chromatography Techniques TLC and Paper chromatography; Chromatographic methods for macromolecule separation – Gel permeation, Ion exchange, Hydrophobic, Reverse-phase and Affinity chromatography; HPLC and FPLC; Criteria of protein purity.

Electrophoretic techniques

Theory and application of Polyacrylamide and Agarose gel electrophoresis; Capillary electrophoresis; 2D Electrophoresis; Disc gel electroporesis, Gradient electrophoresis; pulsed field gel electrophoresis

Unit III

Centrifugation

Basic principles; Mathematics & theory (RFC, Sedimentation coefficient etc.); Types of centrifuge – Microcentrifuge, High speed & Ultracentrifuges; preparative centrifugation; Differential & density gradient centrifugation; Applications (Isolation of cell components); Analytical centrifugation; Determination of molecular weight by sedimentation velocity & sedimentation equilibrium methods.

Unit IV

Radioactivity and stable isotopes; Pattern and rate of radioactive decay; Units of radioactivity; Measurement of radioactivity; Geoger-Muller counter; solid & Liquid scintillation counters (Basic Principle, instrumentation & technique); Brief idea of radiation dosimetry; Ceremkov radiation; Autoradiography; Measurement of stable isotopes; falling drop method; Applications of isotopes in biochemistry; Radiotracer techniques; Distribution studies; Isotope dilution technique; Metabolic studies; Clinical application; Radioimmunoassay.

Unit V

Advanced Techniques

Protein Crystallization; Theory and methods; API-electrospray and MALDI-TOF; Mass spectrometry; DNA & Peptide solid phase chemical synthesis.

Texts/References

- Freifelder D.; Physical Biochemistry, Application to Biochemistry and Molecular Biology, 2nd edition, W.H. Freeman & Company, San Fransisco, 1982.
- Keith Wilson and John Walker, Principles and techniques of practical Biochemistry, 5th Edition, Cambridge University Press, 2000.
- D. Holme & H. Peck, Analytical Biochemistry, 3rd Edition, Longman, 1998.
- R. Scopes, Protein purification – Principles & Practices, 3rd Edition, Springer Verlag,1994.

BT105PC- Lab-1 Biochemistry - 3 Credits

- Preparation of Acetic-Na Acetate Buffer system and validate the Henderson-Hasselbach equation.
- Determine an unknown protein concentration by plotting a standard graph of BSA using UV/Vis spectrophotometer and validating the beer-Lambert's Law.
- Estimation of DNA/ RNA/ Sugars/Lipids
- Titration of Amino Acids and separation of aliphatic, aromatic and polar amino acids by TLC.
- Demonstration of HPLC and Mass spectroscopy
- Purification of Protein/Enzyme.
  a) Preparation of cell-free lysates
  b) Ammonium Sulfate precipitation
  c) Ion-exchange /Gel Filtration Chromatography
  f) Generating a Purification Table
  g) Assessing purity by SDS-PAGE Gel Electrophoresis

BT106PC Lab -2 Microbiology – 3 Credits

- Sterilization, disinfection, safety in microbiological laboratory.
- preparation of media for growth of various microorganisms.
- Identification and culturing of various microorganisms.
- Enumeration of microorganisms
- Gram staining, Spore staining, Negative staining, Volutine granule staining, Motility test
- Growth curve, measure of bacterial population by turbidometry and studying the effect of temperature, pH, carbon and nitrogen.
- Assay of antibiotics production and demonstration of antibiotic resistance.
- Antibiotic sensitivity
- MPN
- IMViC test

BT108 LC Language Communication Skills 1- Credit

Process of communication

Concept of effective communication-setting clear goals for communication; Determining outcomes and results; Initiating communication; avoiding breakdowns while communicating; Creating value in conversation, Barriers to effective communication;

Non verbal communication-Interpreting non verbal cues; Importance of body language, Power of effective listening; recognizing cultural differences.

Presentation skills
Formal presentation skills; Preparing and presenting using Over Head Projector, Power Point, Defending Interrogation; Scientific poster preparation & presentation; Participating in group discussions

Technical Writing Skills
Types of reports; Layout of a formal report; Scientific writing skills: Importance of communicating Science; problems while writing a scientific document; Plagiarism; Scientific Publication Writing: Elements of a Scientific paper including Abstract, Introduction, Materials & Methods, Results, discussion, References; Drafting titles and framing abstracts

Computing Skills for Scientific Research
Web browsing for information search; search engines and their mechanism of searching; Hidden Web and its importance in scientific research; Internet as a medium of interaction between scientists; Effective email strategy using the right tone and conciseness
Texts/References
Mohan Krishna and N. P. Singh, speaking English effectively, Macmillan, 2003.

SEMESTER II

BT201CC Molecular Biology – 3 Credits

Unit I
Genome organization
Organization of bacterial genome; Structure of eukaryotic chromosomes; Role of nuclear matrix in chromosome organization and function; Matrix binding proteins; Heterochromatin and Euchromatin; DNA reassociation kinetics (Cot curve analysis); Repetitive and unique sequences; Satellite DNA; DNA melting and buoyant density; Nucleosome Phasing; DNase I hypersensitive regions; DNA methylation & Imprinting.

Unit II
DNA Structure; Replication, Repair & Recombination
Structure of DNA - A, B, Z and triplex DNA; DNA Replication: Replicons, mapping origins of replication, salient features of replication : initiation, elongation and termination in prokaryotes and eukaryotes; Enzymes and accessory proteins; Fidelity. DNA repair: Enzymes, Photoreactivation; Nucleotide excision repair; Mismatch correction; SOS repair; Recombination: Homologous and non-homologous; Site specific recombination; Chi sequences in prokaryotes. Gene targeting; Gene disruption; FLP/FRT and Cre/Lox recombination.

Unit III
Prokaryotic & Eukaryotic Transcription
Prokaryotic Transcription; Transcription unit; Promoters-Constitutive and Inducible; Operators; Regulatory elements; Initiation; Attenuation; Termination-Rho-dependent and

independent; Anti-termination; Transcriptional regulation-Positive and negative; Operon concept - lac, trp, ara, his, gal; Transcriptional control in lambda phage. Eukaryotic transcription and regulation; RNA polymerase structure and assembly; RNA polymerase I, II, III; Eukaryotic promoters and enhancers; General Transcription factors; TATA binding proteins (TBP) and TBP associated factors (TAF); Activators and repressors; Transcriptional and post-transcriptional gene silencing.

Unit IV

Post Transcriptional Modifications

hnRNA, mRNA processing: 5'-Cap formation; 3'-end processing and polyadenylation; RNA Splicing; processing of tRNA and rRNA; RNA editing; Nuclear export of mRNA; mRNA stability; Catalytic RNA.

Translation & Transport

Translation machinery; Ribosomes; Composition and assembly; Universal genetic code; Degeneracy of codons; Termination codons; Isoaccepting tRNA; Wobble hypothesis; Mechanism of initiation, elongation and termination; Co-and post-translational modifications; Genetic code in mitochondria; Transport of proteins and molecular chaperones; Protein stability; Protein turnover and degradation.

Unit V

Mutations; Oncogenes and Tumor Suppressor genes

Nonsense, missense and point mutations; Intragenic and Intergenic suppressions; Frameshift mutations; Physuicak, Chemical and biological mutagens; Transposition – Transposable genetic elements in prokaryotes and eukaryotes; Mechanisms of transposition; Role of transposons in mutation; Viral and cellular oncogenes; Tumor suppressor genes from humans; Structure, function and mechanism of action of pRB and p53 tumor suppressor proteins; Activation of oncogenes and dominant negative effect; Suppression of tumor suppressor genes; Oncogenes as transcriptional activators.

Text/References

Benjamin Lewin, Gene IX, 9th Edition, Jones and Barlett Publishers, 2007

J.D. Watson, N.H. Hopkins, J.W. Roberts, J.A. Seitz & A.M. Weiner; Molecular Biology of the Gene, 6th Edition, Benjamin Cummings Publishing Company Inc, 2007.

Alberts et al; Molecular Biology of the Cell, 4th edition, Garland, 2002.

BT202 CC. Intellectual Property Rights & Biosafety – 3 Credits

Unit I

Introduction to Intellectual Property. Types of IP: Patent, Trademarks, Copyright & Related Rights, Industrial Design, TYraditional Knowledge, Geographical Indications, Protection of New GMOs; International framework for the protection to History of GATT,WTO, WIPO and TRIPS

Unit II

Concept of 'prior art". Invention in context of "prior art"; Patent databases; Searching International Databases; Country –wise patent searches (USPTO, EPO, India etc.); Analysis and report formation.

Unit III

Basics of Patents. Types of patents; Indian Patent Act 1970; Recent Amendments; Filing of a patent application; Precautions before patenting-disclosure/non-disclosure; WIPO Treaties; Budapest Treaty; PCT and Implications; Role of a Country Patent Office; Procedure for filing a PCT application.

Unit IV

Patent filing and infringement. Patent application-forms and guidelines, fee structure, time frames; types of patent applications: provisional and complete specifications; PCT and convention patent applications; International patenting-requiremment procedures and costs; Financial assistance for patenting-introduction to existing schemes; Publication patents-gazette of India, status in Europe and US

Patenting by research students, lecturers and scientists-University/organizational rules inIndia and abroad credit sharing by workers, financial incentives

Patent infringement-meaning, scope, litigation, case studies and examples.

Unit V

Biosafety Indroduction; Historical Backround; Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels; Biosafety Levels of specific Mocroorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Agents and Infected Animals; Biosafety guidelines- Government of India; Definition of GMOs & LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculoture;

Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of National Regulations and relevant International Agreements including Cartagena Protocol.

Text Book/ References

- Patent Law, P. Narayan Eastern Law House
- Biotecnological Innovations, Moral restrain and patent Law, Oliver mills
- Intellectual Property 3th Edition, David Bainbridge, Pearson Education
- Patents in Chemistry and Biotechnology. Philip W Grubb, Claren Don Press, Oxford

BT203 CR. Biostatistics and Bioinformatics - 2 Credits

Unit I

Fundamental concepts in applied probability; Exploratory data analysis and statistical inference; Probability and analysis of one and two way samples; discrete and continuous probability models; Expectation and variance; Central limit theorem; Inference; Hypothesis; Critical region and error probabilities, Tests for proportion, Equality of proportions; equality of means of normal population(variance known, variance

unknown0; Chi-square test independence; P-value of the statistic; Confidence limits; Introduction to one way and two way aqnalysis of varioance; Data transformations.

Unit II
Elements of programming languages – C and PERL; Data base concept; Database management system; Database browsing and Data retrieval, Sequance database and genome database, Data Structure and Databaswes; Databases such as Gen Bank; EMBL; DDBJ; Swissprot; PIR MIPS;TIGR; Hovergen; Tair; PlasmoDB; ECDC; Searching for sequence database like FASTA and BLAST algorithm.

Unit III
Cluster analysis; Phylogenetic clustering by simple matching coefficients; Sequence Comparison; Sequence pattern; Regular expression based pattern; Theory of profiles and their use in sequence analysis; Markov models; Concept of HMMS; Baum-Welch algorithm; Use of profile HMM for protein family classificatgion; Pattern recognition methods

Unit IV
Goals of a Microarray experiment; Normalization of Miroarray data; Detecting diferential gene expression; Principal component analysis; Clustering of microarray dat, structure determination by X-ray crystallography; NMR spectroscopy; PDB (Protein Data Bank) and NDB (Nucleic Acid Data Bank); File formats for storage and dissemination of molecular structure.

Unit V
Methods for modeling; Homology modeling; Threading and protein structure prediction; Structure-structure comparison of macromolecules with reference to proteins; Force fields; Molecular energy minimization; monte Carlo and molecular dynamics simulation

Texts/References

- Wayne W.Daniel, Biostatistics : A foundation for Analysis in the Health Sciences, 8th Edition, Wiley, 2004.
- Prem S.Mann, Introductory Statistics, 6th Edition, Wiley, 2006.
- John A Rice, Mathematical Statistics and Data Analysis, 3rd Edition, John A Rice Duxbury Press, 2006.
- Campbell and Heyer, Discovering Genomics, Proteomics, & Bioinformatics, 2nd Edition, Benjamin Cummings, 2002.
- Cynthia Gibas and Per Jambeck, Developing Bioinformatics Computer Skill, 1st Edition, O'Reilly publication, 2001.

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BT204 CC. Immunology - 3 Credits

Unit I
Immunology-fundamental concepts and anatomy of the immune system. Components of innate and acquired immunity; Phagocytosis; Complement and inflammatory responses; Haematopoesis; Primary and secondary lymphoid organs; Lymphatic system; Lymphocyte circulation; Lymphocyte homing; Mucosal and Cutaneous associated

Lymphoid tissue. Mucosal Immunity; Antigens – immunogens, haptens; MHC and MHC genes, MHC and immune responsiveness and disease susceptibility, HLA typing

Unit II

Immune responses generated by B and T lymphocytes. Immunoglobulins-basic structure, classes & subclasses of immunoglobulins, antigenic determinants; Multigene organization of immunoglobulin genes; B-cell receptor; Immunoglobulin superfamily; Principles of cell signaling; Basis of self-non-self discrimination; Kinetics of immune response, memory; B cell maturation, activation and differentiation; Generation of antibody diversity; T-cell maturation, activation and differentiation and T-cell receptors; Functional T cell Subsets; Cell-mediated immune responses, ADCC; Cytokines-properties, receptors and therapeutic uses; Antigen processing and presentation-endogenous antigens, exogenous antigens, non-peptide bacterial antigens and super-antigens; Cell-cell co-operation, Hapten-carrier system.

Unit III

Antigen-antibody interactions. Precipitation, agglutination and complement mediated immune reactions; Advanced immunological techniques –RIA, ELISA, Western blotting, ELISPOT assays for assessing ligand-receptor interaction, CMI techniques-lymphoproliferation assay, Mixed lymphocyte reaction, Cell Cytoxicity assays, Apoptosis, Microarrays, Transgenic mice, Gene knock outs.

Unit IV

Vaccinology. Active and passive immunization; Live killed, attenuated, sub unit vaccines; Role and properties of adjuvants, recombinant DNA and protein based vaccines, ploant-based vaccines, reverse vaccinology, Peptide vaccines, conjugate vaccines; Antibody genes and antibody engineering-Chimeric and hybrid monoclonal antibodies; Catalytic antibodies and generation of immunoglobulin gene libraries.

Unit V

Clinical Immunology. Immunity to Infection: Bacteriua, viral, fungal and parasitic infections, with examples; Hypersensitivity – Type I-IV; Autoimmunity and Types; Mechanism and role of CD4 +Tcells; MHS and TCR in autoimmunity; treatment of autoimmune diseases; Transplantation-Immunological – Tumor antigens; Immune response to tumors and tumor evasion of the immune system , Cancer immunotherapy; Immunodeficiency- Primary and Acquired / secondary

Text /References

- Kuby, RA Goldsby, Thomas J. Kindt, Barbara, A. Osborne Immunology, 6th Edition, Freeman, 2002
- Brostoff J, Seaddin JK, Male D, Roitt IM, Clinical Immunology, 6th Edition, Gower Medical Publishing 2002.
- Janeway et al., Immunobiology, 4th edition, Current Biology publications., 1999
- Paul, Fundamental of Immunology, 4th edition, Lippencott Raven, 1999.
- Goding, Monoclonal antibodies, Academic Press, 1985.

BT205CC Genetics - 3 Credits

Unit I
Mendelism Laws, Dominance, Recessiveness, Segregation, Independence of characters with examples. Phenotype and genotype, Monohybride and Dihybride tests. Incomplete dominance, Co-dominance, Epistasis, Influence of environment on phenotype, Gene interaction

Unit II
Multiple allels, Chromosome theory of heredity, Linkage crossing over. Sex linked inheritance and Hemophilia, Penetrance and expressivity of characters. Complex characters, Chromosomes and sex determination Humans and Flies, Dosage compensation of genes

Unit III
Bacterial genetics, Transformation, Transduction and Conjugation, Different types of plasmids, Transposomes, Integron

Unit IV
Mapping of genes both prokaryotic and Eukaryotic, Morgan Units, Chisquare test, Cytological tests, different types of chromosome banding and Karyotyping. Population genetics and Hardy Weinberg Equilibrium.

Unit V
Extra chromosomal inheritance, plasmid, mitochondrial, plastid DNA as examples
Ploidy: Polyploidy and Aneuploidy

Text /References

- Genetics, A Molecular Approach; T A Brown; 3rd edition; Chapman and Stall
- Principles of genetics SnusTad and Simmons second edition Wiley
- Genetics;Strickbergerr 3rd edition Prentice hall india
- Basic Genetics Robert F Weaver
- Genomes; T A BROWN
- Principles of Genetics eigth edition Gardner , Simmons and snostad
- An introduction to genetic analysis; Griffith Miller, Suzaki and Leowonter Gelbbart 8th edition; Freeman publishers

BT206CP Lab – 3 Molecular Biology – 3 Credits

- DNA isolation – spooling out HMW genomic DNA
- Purification of genomic DNA using organic solvent extractions
- Spectrophotometric quantification of DNA
- Preparation of competent cells
- Transformation of *E.coli* with a standard plasmid. Calculation of transformation efficiency.
- Plasmid DNA isolation
- Agarose gel electrophoresis of DNA

- Purification of DNA from agarose gel – electroelution and purification
- Isolation of total RNA
- Isolation of polyA^+ RNA
- Induction of operon in *E.coli* (using different strains and different conditions)
- Intra-genic complementation in *E.coli*
- Demonstration of *In vitro* transcription, *In vitro* translation, metabolic labeling of proteins.

BT207PC Lab – 4 Biostatistics and Bioinformatics – 2 Credits

Indroduction to MS EXCEL- Use of worksheet to enter data, edit date, copy data, move data. Use of in-built statistical Functions for Computation of Mean, S.D, Correlation, regression coefficients etc. Use of bar diagram, histogram, scatter plots, etc. graphical tools in EXCEl for presentation of data. Introduction to statistical computer package.

Searching PubMed, Introduction to NCBI data bases, BLAST BLASTn, BLASTp PSI-BLAST, Sequence manipulation suite, Multiple sequence alignment, Primer designing, Phylogenetic Analysis. Protein Modeling, Protein structure Analysis, Docking, Ligplot interactions.

BT208PC Lab – 5 Immunotechnology – 3 Credits

1. Selection of animals, Preparation of antigens, Immunization and methods of bleeding, serum separation, Storage.
2. Antibody titre by ELISA method.
3. Double diffusion, Immuno-electrophoresis and Radial Immuno diffusion.
4. Immunoblotting, Dot blot assays
5. Blood smear identification of leucocytes by Giemsa stain
6. Flurochrome – Ab Conjugation
7. Preparation of tissue culture media, membrane filtration.
8. Preparation of single single cell suspension, cell counting and viability
9. Separation of mononuclear cells by Ficoll-Hypaque
10. Macrophage monolayer from peritoneal cavity or macrophage development from cell line and measurement of phagocytic activity
11. Measurement of doubling time, trypsinisation and subculturing
12. Cryopreservation of cell lines thawing and cell growth.
13. Preparation of metaphase chromosomes from cultured cells
14. MTT assay for cell viability and growth.
15. Hybridoma technology and monoclonal antibody production

MTT assay for cell viability and growth

II Semester Electives Courses

BT210EC Microbial Technology - 2 credits

Unit I
Isolation and screening of industrially important microbes; Large scale cultivation of industrial microbes ; strain improvement to improve yield of selected compounds e.g. antibiotics, enzymes or recombinant proteins.

Unit II
Basic principles of bioprocess as applied to selected microbes; Process optimization of selected products. Penicillin, Ethanol, Citric acid.

Unit III
Recombinant protein production in microbes; Commercial issues pertaining to the production of recombinant products from microbes; Downstream processing approaches; Industrial microbes as cloning hosts (streptomyces/Yeast)

Unit IV
Environmental application of microbes; Ore leaching; Toxic waste removal; soil remediation.

Unit V
Microbial application in food and healthcare industries; Food processing and food preservation; Antibiotics and enzymes of pharmaceutical use.

Texts/References
Glazer and Nikaids, Microbial Biotechnology, 2nd Edition, Cambridge University Press, 2007
Comprehensive Biotechnology
Principles of Fermentation Technology.
Journal : (A) Nature Biotechnology
(B) Trends in Microbiology
(C) Current opinion in Microbiology.

BT211EC Molecular Virology – 2 Credits

Unit I General properties of viruses- Structure and Morphology, Cultivation. Methods used for viral quantification and enumeration. Electron-microscopic studies Viral classification DNA and RNA viruses, Laboratory requirements for cultivation. Lawn culture, Embryonated egg inoculation, Animal inoculation, Permissive and non-permissive hosts or cells. Tissue - Types of celllines used for the study Detection of virus growth in cell culture

Unit II Viral Tropism, Factors responsible for viral tropism. Replication of DNA viruses and RNA viruses, effects of viruses on the host cells – cyto-pathic effect. Immune aversion mechanism of viruses, Emerging viral diseases. Virus Host interaction- Acute infection, chronic/persistent infection latent infection and slowly progressive virus infection Viral inclusion bodies - methods of staining and demonstration.

Unit III Animal viruses Poxviruses, Papilloma Viruses, Human Herpes Viruses, Adenoviruses, Picornaviruses, Rotaviruses, Paramyxoviruses and Rhabdoviruses, Reoviruses, Retroviruses Flaviviruses, Coronaviruses Human Swine fever virus Cancer causing RNA and DNA Viruses. Viral arthritis. Control of animal viral diseases, Antiviral agents, Combination therapy, Nucleic acid based therapies

Unit IV

Bacteriophages Lambda phage, T phages, Filamentous phages M 13 phages. Lytic and lysogenic cycles of Lambda phage. M13 replication Types of plant viruses, Economic losses due to important viruses;DNA viruses, RNA viruses, satellite viruses, satellite RNA, satellite DNA, viroids, virusoids; Disease symptoms, local and systemic movement of viruses, plasmodesmata and virus movement. Genomic Organization of DNA viruses; Caulimovirus – eg. Cauliflower mosaic virus, Replication of CaMV, Badnavirus – Rice trungro virus (RTBV); Nanovirus – Banana bunchy top virus. Potato virus Y (PVY), , Citrus triesteza virus; Bromovurudae, Alfalfa mosaic virus, Rice dwarf virus.

Unit V

Virus detection and diagnosis; Infectivity assays- Sap transmission, insect vetor transmission, agroinfection (using Agrobacterium); Ultracentrifugation, electron microscopy, serological methods, immunelectrophoresis in gels, direct double-antibody sandwich method, Dot ELUSA, Immunosorbent electron microscopy (ISEM), Decoration technique, Polymerase chain reaction; DNA and oligonucleotide microarray; Gene silencing, PTGS & TGS, viral suppressors of gene silencing.

Texts/ References

Ed. C.L. Mandahar, Molecular biology of Plant viruses, Kluwer academic publishers, Dordrect, 1999.

Roger Hull (Ed), Mathews Plant Virology, 4th Edition, Academic Press, San Diego, 2002.

D.G.A. Walkey (Ed), Applied Plant Virology, 2nd Edition, Chapman & Hall, London, 1991.

Text Book of Microbiology :Ananthanarayanan & Jayaram Panikker

Medical Virology : Fenner and White

Principles and Practice of Infectious diseases – Madell, Bennett, Dolin Vol- 1 & 2

Medical Microbiology : David Greenwood, Slack, Peutherer

Essentials of Diagnostic Virology: G. Storch

Notes on Medical Virology By Morag.C. Timbury

Diagnostic methods in Clinical Virology : N.R. Grist

Fundamentals of Molecular Virology By Nicholas H. Acheson

BT212EC Cancer Genetics – 2 Credits

Unit I

Introduction: Types and general characteristics of tumours; Chromosomal aberrations in neoplasia; Cell cycle check point and cencer.

Unit II

Cell transformation and tumorigenesis: Oncogenes; Tumour suppressor Genes; DNA repair genes and genetic instability; Epigenetic modification, telomerase activity, centrosome malfunction; Genetic heterogeneity and clonal evolution.

Unit III

Familial cancers: Retinoblastoma, wilms' tumour, Li-Fraumeni syndrome, colorectal cancer, breast cancer; Genetic predisposition to sporadic cancer.

Unit IV

Tumour progression: angiogenesis and metastasis; Tumour specific markers

Unit V

Cancer and environment: physical, chemical and biological carcinogens; Cancer risk assessment, gene therapy and counseling.

Texts/References

Genetics of Cancer: Genes Associated with Cancer invasion, Metastasis and Cell Proliferation; G V Sherbet and M S Laksmi; Academic Loress
The Biology of Cancer; Robert A Weinberg; Garland Science.
Cancer and the search for selective biochemical inhibitors; E J Hoffman; CRC

Alberts et al., The science of Genetics, Saunders, 1999.
Alberts et al., Molecular Biology of the Cell, Carland 2008.
Benjamin, Genetics: A Conceptual Approach, 3rd Edition, Freeman, 2007.
Berg and Singer, Genes and Genome, 1998.
Black, Microbiology: Principles and Explorations, 6th Edition Wiley, 2004.
Cowell, Molecular Genetics of Cancer, 2nd Revised Edition, Bios, 2001.

BT213EC Pharmacogenomics – 2 Credits

Unit I

Pharmacogenomics; Pharmacogenetics; Benefits; Practical applications of pharmacogenomics; The promise of Pharmacogenimics today leading to personalized medicines; human genetic variation-examples of CYP gene variations leading to variable metabolism of drugs; Distribution of variation; Mutations & its kind; Natural selection; variation in ethnic groups, races.

Unit II

Pharmacology; clinical pharmacology; Drugs; Drug Legislation & safety; Types of Drugs – examples of latest drugs; Drug potency and Efficacy; ADME of Drug- Drug absorption; Drug distribution; Drug metabolism & Drug excretion;

Unit III

Drug efficacy & toxicity; drug therapeutic levels; Therapeutic Index; Drug abuse; Drug respose in patients by correlating gene expression; Regulation of gene expression; Polymorphism; Alleles; Single nucleotide polymorphism; Genotyping; example of TPMT and DPD gene mutation and their impact in treatment strategy.

Unit IV

Genetic markers-Biomarkers in early drug development; Biomarkers in Clinical development; Biomarkers for molecular Diagnostics – example of cancer biomarkers; Pharmacogenetics & drug development.

Texts/References

Wu R and Lin M, Statstical & Computational Pharmacogenomics, CRC Press, 2008.
Yan Q Pharmacogenomics in Drug Discovery and development, Springer-Verlag New York, LLC, 2008.
Meyer UA and Tyndale RF, Pharmacogenomics, 2nd Edition, CRC Press, 2005.
Innocenti F, Pharmacogenomics: Methods and Applications Springer-Verlag New York, LLC, 2005.
Rothstein MA and Collins FS, Pharmacogenomics: Social, Ethical, and Clinical Dimensions, Wiley John & Sons, Inc., 2003.

BT214EC Stem Cell Technology – 2 credits

Unit I

Introduction to stem Cells
Definition, Classification and Sources

Unit II

Stem cell differentiation, Blastocyst and inner cell mass cells; Organogenesis; Mammalian Nuclear Transfer Technology;

Unit III

Characterization of stem cell, Stem cells cryopreservation.

Unit IV

Application of Stem Cells
Overview of embryonic and adult stem cells for therapy Neurodegenerative diseases; Parkinson's, Alzheimer, Spinal Code Injuries and other Brain Syndromes; Tissue systems Failures; Diabetes; Cardiomyropathy; Kidney failure; Liver failure; Cancer; Hemophilia etc.

Unit V

Human Embryonic Stem Cells and Society
Human stem cells research: Ethical considerations; Stem cell religion consideration; Stem cell based therapies: Pre clinical regulatory consideration and Patient advocacy.

Texts/References
Ann A.Kiessling, Human Embryonic Stem Cells: An Introduction to the Science and Therapeutic Potential, Jones and Bartett, 2003.
Peter J. Quesenberry, Stem Cell Biology and Gene Therapy, 1st Edition, Willy-Less, 1998.
Robert Lanja, Essential of Stem Cell Biology, 2nd Edition, Academic Press, 2006.
A.D.Ho., R.Hoffiman, Stem Cell Transplantation Biology Processes Therapy, Willy-VCH, 2006.
C.S. Potten, Stem Cells, Elsevier, 2006.

BT215EC Molecular Therapeutics – 2 Credits

Unit I
Gene therapy; Intracellular barriers to gene delivery; Overview of inherited and acquired diseases for gene therapy; Retro and adeno virus mediated gene transter; Liposome and nanoparticles mediated gene delivery.

Unit II
Cellular therapy; Stem cells: definition, properties and potency of stem cells; Sources: embryonic and adult stem cells; Concept of tissue engineering; Role of scaffolds; Role of growth factors; Role of adult and embryonic stem cells; Clinical applications; Ethical issues

Unit III
Recombinant therapy; Clinical applications of recombinant technology, Erythropoietin; Insulin analogs and its role in diabetes; Recombinant human growth hormone; Streptokinase and urokinase in thrombosis; Recombnant coagulation factors.

Unit IV
Immunotherapy; Monoclonal antibodies and their role in cancer; Role of recombinant interferons; Immunostimulants; Immunosupressors in organ transplants; Role of Cytokine therapy in cancers; Vaccines: types, recombinant vaccines and clinical applications.

Unit V
Gene silencing technology; Antisense therapy; siRNA; Tissue and organ transplantation; Transgenics and their uses; Cloning; Ethical issues.

Texts/References
Bernhard Palsson and Sangeeta N Bhatia, Tissue Engineering, 2nd Edition, Prentice Hall, 2004.
Pamela Greenwell, Michelle McCulley, Molecular Therapeutics: 21st century medicine, 1st Edition, Sringer, 2008.

BT216EC Bacteriology – 2 Credits

Unit I

Prokaryotic cell structure, Nucleolus, plasma membrane, cell wall, flagella, Bacterial electron transport chain

Unit II

Classification, difference between Eu-bacteria and Archebacteria, Biochemical tests Numerical classification, Phylogenic and molecular characterization,

Unit III

Bacterial culture media, types of media, simple chemically defined media, complex media, culturing aerobic and anaerobic bacteria

Unit IV

Bacterial diseases, Typhoid, Cholera leprosy and tuberculosis Clinical symptoms, diagnosis and treatments.

Unit V

Generations of antibiotics and its action, development of resistance against antibiotics, Multiple antibiotic resistance and MAR indexing

SEMESTER – III

BT301CC **Bioprocess Engineering & Technology – 3 Credits**

Unit I

Basic principle of Biochemical engineering

Isolation, screening and maintenance of industrially important microns; Microbial growth and death kinetics (an example from each group, particularly with reference to industrially useful microorganisms); Strain improvement for increased yield and other desirable characteristics

Unit II

Concepts of basic mode of fermentation processes

Types of fermentation and fermenters; Batch, fed batch and continuous fermentation –; Conventional fermentation v/s biotransformation; Solid substrate, surface and submerged fermentation; Fermentation economics; Fermentation media; Fermenter design-mechanically agitated; Pneumatic and hydrodynamic fermenters; Large scale animal and plant cell cultivation and air strerilization, Upstream processing: Media formulation; Sterilization; Aeration and agitation in bioprocess; Measurement and control of bioprocess parameters; Scale up and scale down process.

Bioprocess control and monitoring variables such as temperature, agitation, pressure, pH.

Unit III

Downstream processing

Bioseparation-filtration, centrifugation, sedimentation, flocculation; Cell disruption; Liquid-liquid extraction; purification by chromatographic techniques; Reverse osmosis and ultra filtration; Drying; Crystallization; Storage and packaging; Treatment of effluent and its disposal.

Unit IV

Applications of enzymes in food processing

Enzymic bioconversions e.g. starch and sugar conversion processes; High-Fructose Corn Syrup; Intersterified fat; Hydrolyzed protein etc. and their downstream processing; baking by amylases, deoxygenation and desugaring by glucoses oxidase, beer mashing and chill proofing, cheese making by proteases and various other enzyme catalytic actions in food processing.

Applications of Microbes in food process operations and production

Fermented foods and beverages; Food ingredients and additives prepared by fermentation and their purification; fermentation as a method of preparing and preserving foods; microbes and their use in pickling, producing colous and flavours, alcoholic beverages and other products; Process wastes-whey, molasses, starch substrates and other food wastes for bioconversion to useful products; Bioenergy generation;Biofuels; Bacteriocins from lactic ascid bacteria – Production and applications in food preservation.

Unit V

Enzyme Technology-production, recovery, stability and formulation of bacterial and fungal enzymes-amylase, protease, , glucose isomerase; Immobilised Enzyme and Cell based biotransformations-steroids, antibiotics, alkaloids, enzyme/cell electrodes.(to Bioprocess) Immobilization of enzymes and their industrial applications
Production, recovery and scalling up of enzymes and their role in food and other industries;.
Texts/References
Jackson AT., Bioprocess Engineering in Biotechnology, prentice Hall, Engelwood Cliffs, 1991.
Shuler ML and Kargi F., Bioprocess Engineering: Basic concepts, 2nd Edition, prentice Hall, Engelwood Cliffs, 2002.
Stanbury RF and Whitaker A.Principles of fermentation Technology, Pergamon Press, Oxford, 1997.
Baily JE and Ollis DF., Biochemical Engineering fundamentals, 2nd Edition McGraw-Hill Book Co., New York, 1986.
Aiba S, Humphrey AE and Millis NF, Biochemical Engineering, 2nd Edition, University of Tokyo press, Tokyo 1973.
Comprehensive Biotechnology: The principles, Applications and Regulations of Biotechnology in industry, Agriculture and Medicine, Vol 1,2,3 and 4 Young M.M., Reed Elsevier India Private Ltd., India, 2004.
Mansi EMTEL, Bryle CFA, Fermentation Microbiology and Biotechnology, 2nd Edition, 01Taylor & Francis Ltd., UK, 2007.

BT302CC Genetic Engineering – 3 Credits

Unit I

Basic Concepts : Basic principles of genetic engineering. Scope of genetic engineering. Basic tools: restriction and modifying enzymes; DNA ligations: blunt and cohesive end, linkers and adaptors, homopolymer tailing.

Cloning vectors: Plasmids, Bacteriophages (M13 and Lambda), Phagemids, Cosmids, Artificial chromosomes.

Construction of libraries – genomic and cDNA, walking/hopping and jumping libraries.

Unit II

Expression vectors: Expression in prokaryotic and eukaryotic systems. Maximizing gene expression. Antibody based screening for recombinant proteins. Expression of heterologous genes: Bacterial, Yeast, Insect Baculovirus system. Mammalian cells (Human viral vectors, shuttle vector); Intracellular, periplasmic and extra cellular expression, recombinant protein purification – Inclusion bodies, His/GST/MBP tags, protein refolding. Protein-protein interactive screening – yeast two-hybrid system, Phage-display

Introduction of recombinant DNA into prokaryotic and eukaryotic systems – transformation, DNA transfections using various agents, DNA microinjections, Ti-DNA, gene-gun.

Unit III

Recombinant screening and selection – Labeling of DNA – nick translation, random priming, radioactive and non-radioactive labeling, nucleic acid hybridizations: colony, plaque, dot blot, southern and northern, subtractive hybridization, antibody based and functional screening; fluorescent *in-situ* hybridization, chromatin immunoprecipitation, DNA-protein interaction – Gel retardation assay, DNaseI footprinting; methyl intereference assay;

Unit IV

DNA sequencing techniques, Sanger-Coulson method, Maxam Gilbert method, Automated DNA sequencing.

Sit-directed mutagenesis and protein engineering

Polymerase Chain Reaction: basic steps, Primer design, Types of PCR: multiplex, nested, RT-PCR, real-time, touchdown, hot-start, colony etc. Applications of PCR.

Study of gene regulation, DNA transfection, Northern analysis, S1 mapping, Primer extension, RNase protection and Reporter assays.

Transgenic and gene Knockout technologies, Gene therapy, Vectors and gene delivery, Gene replacement/augmentation, Gene correction, Gene regulation, RNAi and gene-silencing.

DNA Microarray technology: Production and types of microarrays and applications.

Unit V

Molecular mapping of genome. Genetic and physical maps, Chromosome micro-dissection and microcloning, Molecular markers in genome analysis (RFLP, RAPD, and AFLP analysis, molecular markers linked to disease resistant genes). Application in forensic, disease prognosis, genetic counseling, pedigree analysis, taxonomy and biodiversity.

REFERENCE

Principles of Gene Manipulation – Primrose, Twyman and Old. 6th edition
Molecular Cloning : A laboratory manual- Sambrook and Russell. Vol I,II, and III CSHL.
DNA cloning: A practical approach- D.M Glover and B,D, Hames
Molecular and cellular methods in biology and medicine- Kaufman
Methods in enzymology- Vol 152: A guide to molecular cloning techniques- S.L. Berger and A.R. Kimar
Methods in enzymology: Vol 185: gene expression technology- D.V. Goeddel
DNA science: A first course in recombinant technology: D. A. Mickloss and G. A. Frier

Molecular biotechnology- S.B. Primrose
Molecular biotechnology- Glick and Pasternak

BT303CC Genomics and proteomics – 2 Credits

Unit – I

Introduction, Structural organization of genome in prokaryotes and Eukaryotes; Organelle DNA –mitochondrial, chloroplast; DNA sequencing-principles and translation to large scale projects; Recognition of coding and non-coding sequences and gene annotation; Tools for genome analysis – RFLP, DNA fingerprinting , RAPD, PCR, Linkage and pedigree analysis-physical and genetic mapping.

Unit – II

Genome sequencing projects

Microbes, plants and animals; accessing and retrieving genome project information from web; Comparative genomics, Identification and classification using molecular markers-165 rRNA typing/sequencing, ESTs and SNPs.

Unit III

Proteomics

Protein analysis (includes measurement of concentration, amino-acid composition, N-terminal sequencing 2-D electrophoresis of proteins; isoelectric focusing; Peptide fingerprinting; LC/MS-MS for identification of proteins and modified proteins; MALDI-TOF; SAGE and Differential display Proteomics, Protein-protein interactions, Yeast two hybrid system.

Unit - IV

Pharmacogenetics

High throughput screening in genome for drug discovery-identification of gene targets, Pharmacogenetics and drug development.

Unit - V

Functional genomics and proteomics

Microarray ; Protein and peptide microarray-based technology; PCR-directed protein in-situ arrays; Structural proteomics

Texts/References

1. Voet D, voet JG & Pratt CW, Fundamentals of Biochemistry, 2nd Edition, Wiley 2006
2. Brown TA, Genomes, 3rd Edition. Garland Science 2006
3. Campbell AM & Heyer Lj, Discovering Genomics, Proteomics and Bioinformatics, 2nd Edition. Benjamin Cummings 2007
4. Primrose S & Twyman R, Principles of Gene Manipulation and Genomics, 7th Edition, Blackwell, 2006.
5. Glick BR & Pasternak JJ, Molecular Biotechnology, 3rd Edition, ASM Press, 1998.

BT304CC Plant Biotechnology – 3 Credits

Unit – I

Plant Tissue Culture

Historical Perspective; Totipotency; Organogenesis; Somatic embryogenesis; Regulation and applications; Artificial seed production; Micropropagation; Somaclonal variation; Androgenesis and its applications in genetics and plant breeding; Germplasm conservation and cryopreservation.

Protoplast Culture and Somatic Hybridization

Protoplast isolation; Culture and usage; Somatic hybridization – methods and applications; Cybrids and somatic cell genetics.

Unit II

Agrobiology

Agrobacterium-plant interaction; Virulence; Ti and Ri plasmids; Opines and their significance; T-DNA transfer; Disarming the Ti plasmid.

Genetic transformation

Agrobacterium-mediated gene delivery; Cointegrate and binary vectors and their utility; Direct gene transfer-PEG- mediated, electroporation, particle bombardment and alternative methods; Screenable and selectable markers; Characterization of transgenics; Chloroplast transformation; Marker-free methodologies; Gene targeting.

Unit III

Molecular Mapping & Marker Assisted Selection (MAS)

Quantitative and qualitative traits; MAS for genes of agronomic importance, e.g. insect resistance, grain quality and grain yield; Molecular polymorphism, RFLP, RAPD,STS,AFLP SNP markers; Construction of genetic and physical map; Gene mapping and cloning.

Strategies for Introducing Biotic and Abiotic stress Resistance/Tolerance

Bacterial resistance; Viral resistance; Fungal resistance; insects and pathogens resistance; Herbicide resistance; Drought, salinity, thermal stress, flooding and submergence tolerance.

Unit - IV

Genetic Engineering for Plant Architecture and metabolism

Seed storage proteins; Protein engineering; Vitamins and other value addition compounds; Source-sink relationships for yield increase; Post-harvest bioengineering; Plant architecture; Flowering behaviour.

Plant as Biofactories

Concept of bifactories; Fermentation and production of industrial enzymes, vitamins and antibiotics and other biomolecules; Cell culture for secondary metabolite production; production of pharmaceutically important compounds; .

Unit - V

Plant Genomics

Identification of candidate genes using genetic information(positional cloning), using biochemical and expression analysis (microarray analysis, proteomics, metabolomics); Characterization and functional analysis of candidate genes: transformation, mutant populations, knockout systems; Heterologous expression systems; protein analysis; Bioinformatics and databases;genoinformatics.

Plant genetic resources; Biosafety and containment practices

Texts/References

Adrian Slater, Nigel Scott and Mark Fowler, Plant Biotechnology: The genetic manipulation of plants, 1st Edition, Oxford University Press, 2003

Edited by BR Jordan, 2nd Edition, The Molecular Biology and Biotechnology of Flowering, CABI, 2006.

Neil Wille, Phytoremediation: Methods and Reviews, 1st Edition, Humana Press, 2007.

Denis Murphy, Plant Breeding and Biotechnology: Social Context and the Future of Agriculture, Cambridge University Press, 2007.

BT305CC Immunotechnology – 3 Credits

Unit. I

Introduction to Immunotechnology

Kinetics of Immune response, memory; Principles of Immunization; Techniques for analysis of Immune response.

Unit II

Antibody Related Techniques Immuno-chemistyry of Antigens – immunogenecity, haptens, Toxins – Toxiods, Hapten-carrier system; Genetic bases of immune response – Heterogenecity; Role and properties of adjuvants, Immune modulators; B cell epitopes; Hybridoma Rabbit, human; Antigen – Antibody interaction, affinity , cross reactivity, specificity, epitope mapping; Immuno assays RIA, ELISA, Western blotting, ELISPOT assay, immunofluorescence, Surface plasmon resonance, Biosensor assays for assessing ligand – receptor interaction.

Unit III

New Generation Antibodies Multigene organization of Immunoglobulin genes, Ab diversity; Antibody engineering; Phage display libraries; Antibodies as in vitro and in vivo probes.

Unit IV

CMI and Imaging techniques CD nomenclature, Identification of immune Cells; Priciple of Immunofluorescence Microscopy, Flurochromes, Staining techniques for live cell imaging and fixed cells; Flow cytometry, Instrumentation, Applications; Cell Functional Assays – Iymphoproliferation, Cell Cytoxicity, mixed lymphocyte reaction, Apoptosis, Cytokine expression; Cell cloning, Reporter Assays, In-situ gene expression techniques;

Cell imaging Techniques- In vitro and In vivo, Immuno-electron microscopy; In vivo cell tracking techniques; Microarrays; Transgenic mice, gene knock outs.

Unit V

Vaccine technology Rationale vaccine design based on clinical requirements: Hypersensitivity, Immunity to Infection, Autoimmunity, Transplantation, Tumor immunology, immunodeficiency; Active immunization, live, killed, attenuated, Sub unit vaccines; Recombinant DNA and protein based vaccines, plant-based vaccines and reverse vaccinology; Peptide vaccines, conjugate vaccines; Passive Immunization; Antibody, Transfusion of immuno-competent cells, Stem cell therapy; Cell based vaccines.

Texts/References

1. F.C. Hay, O.M.R. Westwood, Practical Immunology, 4th Edition-, Blackwell publishing, 2002
2. S.Hockfield, S. Carlson, C. Evans, P. Levitt, J. Pintar, L.Silberstein, Selected Methods for antibody and Nuxleic Acid probes, Volumel, Cold Spring Harbor Laboratory Press, 1993.
3. Ed Harlow, David Lane, Antibodies Laboratory Manual, Cold spring Harbor, Laboratory Press, 1988.

BT306PC Lab – 6 Bioprocess Engineering – 3 Credits

1. Isolation of industrially important microorganisms for microbial Processes(Penicillium.sp)
2. Microbial production of citric acid using *Aspergillus niger*
3. Microbial production of antibiotics(penicillin)
4. Production and estimation of Protease
5. Use of alginate for cell immobilization
6. Rheology of microbial cultures and biopolymers and determination of various rheological constants.
7. Production of microbial products in bioreactors..
8. Production and purification of various enzymes from microbes..
9. Microbial production and downstream processing of an enzyme, e.g. amylase.
10. Various immobilization techniques of enzymes and use of alginate for immobilization
11. Prevention of Foam and vortex formation in Bioreactors.
12. Production of ethanol using immobilized Saccharomyces cerevisiae

BT307PC Lab – 7 Genetic Engineering – 3 credits

1. Bacterial culture and antibiotic selection media
2. Restriction of plasmids – setting up a restriction reaction
3. Restriction of genomic DNA
4. DNA ligation – setting up a ligation reaction
5. Restriction mapping using circular and linear DNA
6. Foreign gene expression in *E.coli* (using GFP cDNA)

7. PCR – setting up a PCR reaction
8. Southern blotting
9. Electrophoresis of RNA and Northern Blotting
10. Shot-gun cloning in a standard plasmid vector –
    preparation of vector,
    insert preparation by fractionation of genomic DNA digest, electro-elution and purification
    ligation of inserts into vectors
    transformation into an appropriate strain (DH5α, JM109, BL 121 etc)
    blue-white selection
    minipreps of recombinants
    restriction for cloned DNA insert release

BT308PC Lab – 8 Plant Biotechnology – 3 Credits

1. Preparation and sterilization of glasswares, explant.
2. Preparation stock solution and media for tissue culture.
3. Initiation and maintenance of callus.
4. Organogenesis from callus
5. Somatic embryogenesis from root cultures.
6. Induction of haploids from anther and pollen cultures
7. Isolation and culture of protoplasts from leaf/callus by enzymatic method
8. RAPD analysis of plant DNA

BT402CC Bioentrepreneurship - 3 Credits

Unit I

Accounting and finance

Taking a decision on starting a venture; assessment feasibility of a given venture/new venture;approaching a bank for a loan; source of financial assistance; making a business venture; plants for sseeking loans from financial institutions and banks; funds from bank for capital expenditure and for working; statutory and legal requirements for starting a company;budget planning and cash flow; management;basics in accounting practices; concept of balance sheet; double entry book keeping; estimation of income, expenditure, profit, income tax.

Unit II

Marketing

Assessment of market demand for potential products, market conditions,segments; predictions of market changes;identifying needs of customers including gaps in the market;packaging the product; market linkages;branding issues; developing distribution channels;pricing;policies;competition;promotion/advertising.

Unit III

Negotiations/strategy

With financiers, bankers, with government, law enforcement authorities, wwith companies/institutions for technology transfer;dispute resolution skills; external environmental/ changes; crisis/avoiding/managing; broader vision and global thinking.

Unit IV

How to use IT[Information Technology] for business administration; use of IT in improving business performance; available software for better financial management; e-business set up and management.

Unit V

Leadership skills; managerial skills; organizational structure; pros and cons of different structures; team building;team work; appraisal;rewards in small scale set up.
Support mechanisms for entrepreneurship in india.
Role of knowledge centre and R and D
Role of knowledge centres like universities and research institutes; role of technology and upgradation; assessment of scale of development of technology; managing technology;transfer and regulation of transfer of foreign technologies; technology transfer agencies.

References

- Bioentrepreuership is consolidation the answer to Biotechnology's financial need, Stephan M. Edginton. Nature America Incorporated
- Hand book of Bioentrepreneurship. Holger Palzeit and Thomas Brener. Springer
- Biotechnology Entrepreneurship, Michael L Salgaller. Logos Press