

M.Sc.
Biotechnology

Prospectus No. 201111214

संत गाडगे बाबा अमरावती विद्यापीठ
SANT GADGE BABA
AMRAVATI UNIVERSITY

विज्ञान विद्याशाखा
(FACULTY OF SCIENCE)

PROSPECTUS

OR

MASTER OF SCIENCE (BIOTECHNOLOGY)
(SEMESTER PATTERN TWO YEAR DEGREE COURSE
SEMESTER-I EXAM. W/2010
SEMESTER-II EXAM. S/2011
SEMESTER-III EXAM. W/2011
SEMESTER-IV EXAM. S/2012



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Dineshkumar Joshi
Registrar
Sant Gadge Baba
Amravati University
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SANT GADGE BABA AMRAVATI UNIVERSITY

SPECIAL NOTE FOR INFORMATION OF THE STUDENTS

- (1) Notwithstanding anything to the contrary, it is notified for general information and guidance of all concerned that a person, who has passed the qualifying examination and is eligible for admission only to the corresponding next higher examination as an ex-student or an external candidate, shall be examined in accordance with the syllabus of such next higher examination in force at the time of such examination in such subjects papers or combination of papers in which students from University Departments or Colleges are to be examined by the University.
- (2) Be it known to all the students desirous to take examination/s for which this prospectus has been prescribed should, if found necessary for any other information regarding examinations etc., refer the University Ordinance Booklet the various conditions/provisions pertaining to examination as prescribed in the following Ordinances.

- Ordinance No. 1 : Enrolment of Students.
- Ordinance No. 2 : Admission of Students
- Ordinance No. 4 : National cadet corps
- Ordinance No. 6 : Examinations in General (relevant extracts)
- Ordinance No. 18/2001 : An Ordinance to provide grace marks for passing in a Head of passing and Improvement of Division (Higher Class) and getting Distinction in the subject and condonation of deficiency of marks in a subject in all the faculties prescribed by the Statute NO.18, Ordinance 2001.
- Ordinance No. 9 : Conduct of Examinations (relevant extracts)
- Ordinance No. 10 : Providing for Exemptions and Compartments
- Ordinance No. 19 : Admission of Candidates to Degrees.
- Ordinance No. 109 : Recording of a change of name of a University student in the records of the University.

Ordinance No. 6/2008 : For improvement of Division/Grade.

Ordinance No.19/2001 : An Ordinance for Central Assessment Programme, Scheme of Evaluation and Moderation of answerbooks and preparation of results of the examinations, conducted by the University, Ordinance 2001.

Dineshkumar Joshi
Registrar
Sant Gadge Baba
Amravati University.

PATTERN OF QUESTION PAPER ON THE UNIT SYSTEM.

The pattern of question paper as per unit system will be broadly based on the following pattern

- (1) Syllabus has been divided into units equal to the number of question to be answered in the paper. On each unit there will be a question either a long answer type or a short answer type.
- (2) Number of question will be in accordance with the unit prescribed in the syllabi for each paper i.e. there will be one question on each unit.
- (3) For every question long answer type or short answer type there will be an alternative choice from the same unit. However, there will be no internal choice in a question.
- (4) Division of marks between long answer and short answer type question will be in the ratio of 40 and 60
- (5) Each short answer type question shall contain 4 to 8 short sub question with no internal choice.

Syllabus Prescribed for M.Sc. Biotechnology

SEMESTER I

Theory Paper-BT- 101 : CELL BIOLOGY

UNIT-I : **Origin of cells and unicellular evolution:** Origin of basic biological molecules; abiotic synthesis of organic monomers and polymers; concept of Oparin and Haldane; experiment of Miller (1953); the first cell; evolution of prokaryotes; origin of eukaryotic cells; evolution of unicellular eukaryotes; anaerobic metabolism, photosynthesis and aerobic metabolism. Diversity of cell size and shape. Cell theory. Structure of Prokaryotic and Eukaryotic cells - Isolation and growth of cells.

Microscopic techniques: Visualization of cells and subcellular components by light microscopy, resolving powers of different microscopes, microscopy of living cells, scanning and transmission microscopes, different fixation and staining techniques for EM, freeze-etch and freeze-fracture methods for EM, image processing methods in microscopy.

Sub-cellular fractionation and criteria of functional integrity.

UNIT-II : **Structural organization and function of intracellular organelles:** Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility, Cell motility- cilia, flagella of eukaryotes and prokaryotes.

Cell signaling: Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways, bacterial and plant two-component signaling systems, bacterial chemotaxis and quorum sensing.

UNIT-III : **Membrane structure and function:** Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, ion pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes.

Cell division and cell cycle: Mitosis and meiosis, their regulation, steps in cell cycle, and control of cell cycle.

Cellular communication: Regulation of hematopoiesis, general principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions,

extracellular matrix, integrins, neurotransmission and its regulation.

UNIT-IV : **Cancer:** Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancer, metastasis, interaction of cancer cells with normal cells, apoptosis, therapeutic interventions of uncontrolled cell growth.

Bioenergetics, glycolysis, oxidative phosphorylation, coupled reaction, group transfer, biological energy transducers.

Cellular energy transactions - role of mitochondria and chloroplast.

UNIT-V : **Basic concepts of development:** Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development.

Gametogenesis, fertilization and early development:

Production of gametes, cell surface molecules in sperm-egg recognition in animals; embryo sac development and double fertilization in plants; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis, establishment of symmetry in plants; seed formation and germination.

Brief introduction to the Life Cycle and Molecular Biology of some important pathogens of AIDS, Malaria, Hepatitis, Tuberculosis, Filaria, Kalazar.

Practicals (BT – 105A)

- 1 Microscopy: Bright field (Flagella staining), Dark Field (Bacterial Motility)
- 2 Cell Diversity (Shape, Size)
- 3 Microtomy techniques (Animal Tissue)
- 4 Instrumental methods for Cell Biology.
- 5 Sub-cellular fractionation by differential centrifugation/Density Gradient Centrifugation.
- 6 Isolation and identification of subcellular organelles (Mitochondria, Chloroplast, Nucleus and Lysosomes)
- 7 Histochemical techniques: (Differential Staining, Barr Body Demonstration, Blood cell counting and ABO blood grouping)

- 8 Mitosis and Meiosis.

Recommended readings

1. Molecular Biology of Cell, By Bruce Alberts 4th Edition
2. Molecular Cell Biology, Lodish (5th Edition)
3. Reproduction in Eukaryotic cells, DM Prescott, Academic press.
4. Developmental Biology, SF Gilbert, Sinauer Associates Inc.
5. Cell in Development and Inheritance, EB Wilson, Mac-Milan, New York.
6. The Coiled Spring, Ethan Bier, Cold Spring Harbor Press.
7. Fertilization, FT Longo, Chapman and Hall
8. Molecular Biology of Steroid and Nuclear Hormone Receptors, LP Freedman, Birkhuser.
9. Molecular Biology of the Cell By Gerrald Kamp 3rd Edition.
10. The Cell By Cooper
11. The cell cycle: Principle of controls By Morgan
12. Biochemistry of Cell signaling By Helmeich

Theory Paper BT-102 : Macromolecules and Enzymology

- Unit-I :** Acids, Bases, pH, pK, buffers, weak bonds, covalent bonds
Laws of thermodynamics, entropy, Gibbs energy, free energy changes and redox potentials, phosphate potential
Mitochondrial respiratory chain: Organization of carrier, proton gradient, iron sulphur proteins and cytochromes.
Reversed electron transfer, respiratory controls and oxidative phosphorylation, uncouplers and inhibitors of energy transfer
ATP: Synthetase complex, microsomal electron transport, partial reduction of oxygen, superoxides

Unit-II : Proteins and Amino Acids

Amino acids: Classification, properties, peptide bond
Anabolism and catabolism of Amino Acids
Proteins: Classification and function
Structure (primary, secondary, tertiary and quaternary), stabilizing bonds, Ramchandran Plot, principle of amino acid sequencing.

Unit-III : Enzymes as Biocatalysts

International classification of enzymes
Enzyme Kinetics (negative and positive co-operativity);

Methods for measuring kinetic and rate constants of enzyme reactions and their magnitudes, Inhibitors, Isozymes
Enzyme turnover: methods of its measurements and significance

Allosteric enzymes, sigmoidal kinetics and their physiological significance. Symmetric and sequential modes for action of allosteric enzymes

Co-enzymes and cofactors: Water soluble vitamins and their co-enzymes, metalloenzymes

General mechanisms of enzyme regulation: Feed back inhibition and feed forward stimulation, enzyme repression, induction and degradation, control of enzyme activity by products and substrates; Ribozymes and abzymes

Unit-IV : Carbohydrates and Lipids

Carbohydrates: Classification, mono-, oligo-, and polysaccharides, physical and chemical properties, sugar acids and amino sugars ;Glycolysis and TCA cycle;

Glycogen breakdown and synthesis; Gluconeogenesis; Interconversion of hexoses and pentoses; ATP cycle and cell bioenergetics

Lipids: Classification (simple, compound and derived lipids), Structure, function and industrial significance, Oxidation of lipids; Biosynthesis of fatty acids; Triglycerides; Phospholipids; Glyco and Lipoproteins; Sterols; Circulating lipids with relevance to pathological changes

Unit-V : Sequencing of proteins and nucleic acids

Protein-protein and protein-ligand interactions, physical and chemical methods for study; Conformational properties of polynucleotide and polysaccharides – secondary and tertiary, structural features and their analysis – Theoretical and experimental; protein folding – biophysical and cellular aspects.

Practicals (BT-105B)

1. Titration of amino acids.
2. Colorimetric determination of pK.
3. Reactions of amino acids; sugars and lipids.
4. Isolation, purity determination and quantitation of cholesterol, DNA and RNA.
5. Quantitation of Proteins and Sugars.
6. Analysis of oils-iodine number, saponification value, acid number.

7. UV, Visible, Fluorescence and IR spectroscopy, Absorption spectra.
8. Separation techniques- Centrifugation, Chromatography (Gel permeation, Ion exchange, TLC etc.) and electrophoresis.
9. Electrophoresis of Proteins - native and under denaturing conditions
10. Electrophoresis of DNA - linear, circular and super coiled.
11. Determination of T_m of nucleic acid
12. Enzyme: purification and kinetic analysis.
13. Immobilization of Enzymes
14. Hydrodynamic properties - measurement and applications.
15. Determination of T_m of nucleic acid.

Recommended readings

1. Lehninger's Principles of Biochemistry (5th edition) by Nelson DL and Cox MM, CBS Publications, 2008.
2. Biochemistry by Stryer L. (5th edition) W.H. Freeman & Co., New York, USA, 1
3. Fundamentals of Enzymology (3rd edition) by Price NC and Stevens L. Oxford University Press, NY, USA, 2000.
4. Principles of protein structure by Shulz and Schirmer, Springer Verlag, 1979 .
5. Fundamentals of Enzymology by Royer. 1989
6. Harper's Biochemistry. (27th Edition) Ed. Murray RK, Granner DK, Mayes PA and Rodwell VW. Appleton and Lange, Stamford, Connecticut. McGraw Hill Companies, 2006
7. Textbook of Biochemistry with Clinical Correlations. (6th Edition) Ed. Thomas M. Devlin. Wiley-Liss Publishers. 2005
8. Genes IX. by Lewin B. Pearson Education International, NJ, USA, 2008.
9. Fundamentals of Biochemistry. (2nd Edition) Ed Voet D and Voet JG. And Pratt CW. John Wiley & Sons, Inc., 2006

Theory Paper BT-103: Microbes: Physiology and Genetics

UNIT I : Prokaryotic Diversity

Bacteria: Purple and green bacteria; Cyanobacteria; Acetic acid bacteria; Spirilla; Spirochaetes; Pseudomonads; Lactic and propionic acid bacteria; Mycobacteria; Rickettsias, Chlamydias and Mycoplasmas.

Archaea: Archaea as earliest life forms; Halophiles; Methanogens; Hyperthermophilic archaea; Thermoplasma.

Eukarya: Algae, Fungi, Slime molds and Protozoa.

Viruses: Bacterial, Plant, Animal and Tumor viruses; Discovery, classification and structure of viruses and importance

UNIT II : Methods in Microbiology

Isolation of Pure culture techniques; Theory and practice of sterilization; Principles of microbial nutrition; Construction of culture media; Enrichment culture techniques for isolation of chemoautotrophs, chemoheterotrophs and photosynthetic microorganisms, Culture collection and maintenance of cultures.

Microbial Evolution, Systematics and Taxonomy

Evolution of earth and earliest life forms; Primitive organisms and their metabolic strategies and molecular coding; New approaches to bacterial taxonomy classification including ribotyping; Ribosomal RNA sequencing; Characteristics of primary domains; Taxonomy, Nomenclature and Bergey's Manual.

UNIT III : Overview of Basic Metabolism & Microbial Nutrition

Metabolic Diversity among Microorganisms
Photosynthesis in microorganisms; Role of Chlorophylls, carotenoids and phycoobilins; Calvin cycle; Chemolithotrophy; Hydrogen - iron - nitrite - oxidizing bacteria; Nitrate and sulfate reduction; Methanogenesis and acetogenesis; Fermentations - diversity, syntrophy, and acetogenesis; Fermentations - diversity, syntrophy, Dearthatophytosis, Aspergilliosis, Blastomycosis, Cryptococcosis, burden of opportunistic fungal infections in immunocompromised hosts with special reference to secondary infections in AIDS and Cancer patients, knowledge about MDR

Chemotherapy/Antibiotics
Antimicrobial agents; Sulfa drugs; Antibiotics: Penicillins and Cephalosporins; Broad- spectrum antibiotics; Antibiotics from prokaryotes; Antifungal antibiotics; Mode of action; Resistance to antibiotics.

UNIT V : Bacterial Genetic System

Transformation, Conjugation, Transduction, Recombination, Plasmids and Transposons. Bacterial genetics map with reference to E coli.

Viruses and Their Genetic System

Phage I and its life cycle; RNA phages; RNA viruses;

Retroviruses.

Genetic Systems of Yeast and Neurospora
Extra-Chromosomal Inheritance

Practical (BT-106A)

- 1) Preparation of liquid and solid media for growth of microorganisms.
- 2) Isolation and maintenance of organisms by plating, streaking and serial dilution methods. Slants and stab cultures. Storage of microorganisms.
- 3) Isolation of pure cultures from soil, water, air and human beings.
- 4) Growth curve; Measurement of bacterial population by turbidometry and serial dilution methods. Effect of temperature, pH and carbon and nitrogen sources on growth.
- 5) Microscopic examination of bacteria, yeast and molds and study of organisms by Gram stain, Acid fast stain and staining for spores.
- 6) Study of mutations by Ames test.
- 7) Assay of antibiotics and demonstration of antibiotic resistance.
- 8) Analysis of water for potability and determination of MPN.
- 9) Bacterial transformation.
- 10) Biochemical characterization of selected microbes.
- 11) Transduction
- 12) One step growth curve of coliphage.
- 13) Isolation of Plasmids.
- 14) CO₂ fixation by photosynthetic microbes.

Recommended readings

1. General Microbiology, Sainer, R. Y., Ingraham, J.L., Wheelis, M.L. and Painter, P.R. The MacMillan Press Ltd.
2. Brock Biology of Microorganisms, Madigan, M.T., Martinko, J.M. and Parker, J. Prentice-Hall.
3. Microbiology, Peizer, M.J. Jr., Chan, E.C.S. and Kreig, N.R., Tata McGraw Hill.
4. Microbial Genetics, Maloy, S.R., Cronan, J.E. Jr. and Freifelder, D. Jones, Bartlett Publishers.
5. Microbiology - a Laboratory Manual, Cappuccino, J.G. and Sherman, N. Addison Wesley.
6. Microbiological Applications, (A Laboratory Manual in General Microbiology) Benson, H.J. WCB: Wm C. Brown Publishers.

Theory Paper BT-104 : Biology of The Immune System

Unit I : **Basic Immunology**: Introduction & overview of the immune system, Phylogeny of Immune System- Types of immunity - innate, acquired, active and passive, Clonal nature of immune response. Organization and structure of lymphoid organs, Nature and Biology of antigens and super antigens, Antibody-structure and function Antigen - antibody Interactions .

Unit II : **Cells of the Immune system**: Hematopoiesis and differentiation, lymphocytes trafficking, T- lymphocytes-cells, B- lymphocytes-cells, Macrophages [Dendritic cells, Natural killer cell and lymphokine activated killer cells, Eosinophiles, Neutrophiles and Mast Cells (antigen presenting cells, cell mediated subset of T-cells, helper and suppressor cells, cell mediated and humoral immunity, antibody dependent cell mediated cytotoxicity, NK cells). Regulation of immune response: Antigen processing and presentation, generation of humoral and Cell mediated immune response(Cell mediated cytotoxicity, lysis and macrophage mediated cytotoxicity), BCR and TCR ,Activation of B and T lymphocytes, Cytokines and their role in immune response- T-cell regulation

Unit III : **Advanced immunology**: Major histo-compatibility complex (MHC): Cellular and molecular aspects: - types, structure and function, MHC restriction, Complement System, Generation of diversity and Immunological tolerance.

Unit IV : **Hyper-sensitivity** : Nature and types of Hypersensitive reactions Types, autoimmunity, Transplantation: tissue and organ grafting and rejection mechanism, Immunity to infectious agents (Intracellular parasites, helminths and viruses

Unit V : **Tumor Immunology** : Cancer and the immune system, AIDS and others immunodeficiencies. Hybridoma Technology and monoclonal antibodies. Concept of idetypes and anti-idetypes, Synthetic vaccines, Role of immunodiagnostic in Biotechnology.

Practical (BT-106B)

1. Blood film preparation and identification of cells
2. Lymphoid organs and their microscopic organization.
3. Immunization and collection of serum.
4. Double diffusion: To perform precipitation reactions in gel by Ouchterlony Technique given an antigen and antibody (double

Immunodiffusion)

5. To perform precipitation tests (a) ring test (b) slide test in solution given an antigen and antibody
 6. Radial Immunodiffusion: To perform single radial Immunodiffusion (Mancini's Technique) using an antigen and antibody.
 7. To perform immunoelectrophoresis given an antigen and antibody.
 8. To perform counter electrophoresis given an antigen and antibody
 9. To perform rapid Agglutination Test for detection of RA factor in serum.
 10. Purification of IgG from serum.
 11. Separation of mononuclear cells by Ficoll-Hypaque.
 12. Western Blotting
 13. To perform ELISA (Using Teaching Kit)
 14. Immunodiagnostic (Demonstration using commercial kits.)
- Recommended readings**
1. Kuby- Immunology -, 4th edition, R A Goldsby, Thomas J, Kindt, Barbara, A. Osborne, (Freeman).
 2. Immunology-A short course, 4th edition, -Eli Beniamini, Richards Coico, Geoffry Sushine, (Wiley-Liss)
 3. Fundamentals of Immunology, William Paul
 4. Essentials of Immunology (6th Edition)- Ivan Roitt
 5. Cellular and Molecular Immunology - Abul K. Abbas, Andrew H. Lichtman and Jordan S
 6. Immunology: An Introduction - Ian R. Tizard
 7. A Handbook of Practical Immunology - G.P. Talwar.

Syllabus for SEMESTER II

Theory Paper BT - 201 : Molecular Biology

- Unit I** : Introduction to molecular biology, basic concept of molecular biology and genetics. DNA Replication : Prokaryotic and eukaryotic replication. Models of replication, theta mode of replication, rolling circle model of replication, Bi directional replication, replication of linear DNA, unidirectional replication. Functions of various proteins involved in prokaryotic replication of DNA and eukaryotic replication. Properties of various replication enzymes. Replication of telomeres and enzymes involved in telomere replication. Repair of DNA and Various enzymes involved in repair of DNA.

Recombination of DNA: Recombination of viral DNA in genome, various models of recombination.

Unit II

- : **Transcription:** Prokaryotic and eukaryotic transcription.

Various RNA polymerases and their properties. Role of sigma sub factor in initiation of transcription. Various domains of sub units of RNA polymerase. Structure and regulation of prokaryotic and eukaryotic genes. Initiation and elongation transcription factors. Various mechanism of termination of transcription. Transcriptional and post transcriptional gene silencing.

Modification of RNA : 5' cap formation, 3' end processing, addition of polyA tail, enzyme involved in polyadenylation and function of poly A tail. Splicing of RNA, classes of introns, exon ligation, editing, Nuclear transport of RNA, and stability of RNA.

Unit III

- : **Translation:** Organization of prokaryotic and eukaryotic translation machinery. Structure of prokaryotic and eukaryotic ribosomes and their components. Shine Dalgarno sequence, Ribosomal protein synthesis.

Regulation of protein synthesis, co and post translational protein modification. Non ribosomal protein synthesis.

Protein localization:

Synthesis of secretory and membrane protein. Mechanism of secretion of extracellular enzymes, Mechanism of localization of proteins in nucleus, chloroplast, mitochondria, peroxisomes and receptor mediated endocytosis.

Unit IV : **Oncogenes and tumor suppressor genes**

Viral and cellular oncogenes, tumor suppressor genes from

humans, structure, function, and mechanism of action of RB and p53 tumor suppressor proteins.

Antisense and ribozyme technology: Molecular mechanism of antisense molecules, inhibition of splicing, polyadenylation and translation, disruption of RNA structure and capping, Biochemistry of ribozyme, strategies for designing ribozyme, Application of antisense and ribozyme technologies. Short Nuclear RNA and their application.

Unit V : **Molecular mapping of genome:**

Genetic and physical maps, physical mapping and map based cloning, choice of mapping population, simple sequence repeat loci, Southern and fluorescence in situ hybridization for genome analysis, Chromosome microdissection and micro cloning.

Molecular markers in genome analysis.

Preliminary concept of RFLP, RAPD, AFLP. Molecular markers linked to disease resistant genes, application of RFLP in forensic, disease prognosis, genetic counseling, pedigree, varietals etc., Animal trafficking and poaching, Germplasm maintenance, taxonomy and Bio diversity.

Genome size, Genome mapping by conjugation, organelle genome with concept of DNA barcoding, and cloning in organelle genome. Genetic defects due to mutations in organelle genome.

Practical (BT-205A)

1. Isolation of genomic DNA
2. Southern blotting
3. RFLP analysis
4. Isolation of RNA
5. Isolation of polyA + RNA
6. Northern blotting
7. Preparation of probes
8. In vitro transcription
9. In vitro translation
10. Metabolic labeling of proteins and immunoprecipitation.

Recommended readings

1. Molecular Cloning- a Laboratory Manual, J. Sambrook, E.F Fritsch and T. Maniatis, Cold Spring Harbor Laboratory Press, New York, 2000

2. Introduction to Practical Molecular Biology, P.D. Dabre, John Wiley & Sons Ltd, New York, 1988
3. Molecular Biology LabFax, TA. Brown (Ed.), Bios Scientific Publishers Ltd, Oxford, 1991
4. Molecular Biology of the Gene (4th Edition), J.D. Watson, N.H. Hopkins, J.W. Roberts, J.A. Steitz and A.M. Weiner, The Benjamin/Cummings Publ. Co., Inc., California, 1987.
5. Molecular Cell Biology (2nd Edition) J. Darnell, H. Lodish and D. Baltimore, Scientific American Books, Inc., USA, 1994
6. Molecular Biology of the Cell (2nd Edition) B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts, and J. D. Watson. Garland publishing, Inc., New York, 1994
7. Gene VI (6th Edition) Benjamin Lewin, Oxford University Press, U.K., 1998
8. Molecular Biology and Biotechnology. A comprehensive desk reference, R.A. Meyers (Ed) VCH Publishers, Inc., New York, 1995
9. Genomes, TS. Brown

Theory Paper BT -202 : Bioprocess Engineering and Technology

Unit-I : Microbial Strain: Screening and Improvement

Industrial microbial strain: Isolation by enrichment culture; Preservation of industrial strains: Methods, Quality control of preserved stock cultures; Strain improvement: Primary and secondary screening; Mutagenesis: Selection of mutants synthesizing improved levels of primary and secondary metabolites; Genetic engineering for strain improvement: General scheme, methods, homologous and heterologous gene expressions (suitable examples).

Unit-II : Microbial Growth and Growth Media

Growth kinetics: Batch and continuous culture (multistage and fed back systems), Fed batch culture; Industrial fermentation media: Ingredients, sources and role of carbon, nitrogen, minerals, growth factors, buffers, precursors, antifoam agents; Medium optimization: Need and significance, Plackett-Burman design; Media Sterilization and Inoculation; Comparative account of batch and continuous sterilization, Factors affecting sterilization; Batch sterilization: Del factor, D and Z value, Methods, Scale-up of batch sterilization; Continuous sterilization: Design and Methods; Filter sterilization of air, media, exhaust air; Development of inocula: Criteria for transfer, Cascade system, Inocula for yeast, bacterial, mycelial processes

Unit-III : Bioreactor Studies

Design of fermenter, Types of bioreactors (stirred tank, packed bed, bubble column, air-lift, MTB, plug flow reactor, rotating biological contactors (RBC), photobioreactors; Mass transfer in bioreactor (oxygen and heat transfer) Measurement and control of bioprocess parameters: pH, temperature, aeration, agitation and foam; Automation for monitoring and control: Online-Offline sensors; Control systems (Two position, proportional, integral and derivative); Use of computers: data logging, data analysis and process control (two layer neural network); Process scale-up: Factors involved, Scale-up window for aeration and agitation, steps involved.

Unit-IV : Downstream Processing

Strategy for recovery; Harvesting of Biomass and Product: Precipitation, Cell aggregation and flocculation, Filtration, Centrifugation; Cell Disintegration: Physical-mechanical and chemical methods; Liquid-liquid extraction: Solvents used, two-phase aqueous extraction, supercritical fluid extraction; Chromatography and membrane processes, pervaporation

Unit-V : Solid State Fermentations

Introduction, General characteristics; Comparison between solid state cultivation (SSC) and submerged liquid culture (SLC); Factors affecting solid state fermentations: Moisture and water activity; temperature and heat exchange; pH, mass transfer; substrate concentration and availability; Economical applications of solid state fermentations

Practical (BT – 205B)

1. Isolation of industrially important microorganisms for microbial processes.
2. Determination of thermal death point (TDP) and thermal death time (TDT) of microorganism for design of a sterilizer.
3. (a) Determination of growth curve of a supplied microorganism and also determine substrate degradative profile.
(b) Compute specific growth rate (μ), growth yield (Y_x/s) from experiment.
4. Simulate the microbial growth in batch, fed batch and continuous culture using fermisym.
5. Determine the mixing time for CSTR.
6. Comparative studies of ethanol production using different

substrates.

7. Microbial production of citric acid using *Aspergillus niger*
8. Microbial production of antibiotics.
9. Production and estimation of Alkaline protease / amylase.
10. Immobilization of enzymes – Invertase/ Protease/ Amylase.
11. Whole cell immobilization (Yeast) for production of Glucose syrup.

Recommended readings:

1. Principles of Fermentation Technology by Stanbury, PF, Whitaker A and Hall SJ. Aditya Books (P) Ltd., New Delhi, 1998.
2. Process Biotechnology: Fundamentals (2nd Edition) by Mukhopadhyay SN, Viva Books Pvt Ltd, New Delhi, 2004.
3. Biotechnology: Hand Book by Board N. Asia Pacific Business Press Inc., New Delhi, 2005.
4. Solid Substrate Cultivation edited by Doelle HW, Mitchell DA and Rolz CE. Elsevier Applied Science, London, 1992.
5. Introduction to Biochemical Engineering by Rao DG, Tata McGraw-Hill Pnb Co Ltd, New Delhi, 2005.
6. Microbial Technology: Fermentation Technology (2nd Edition) Vol. I & II, by Pepler HJ and Perlman D. Academic Press, NY, USA, 2004.
7. Biochemical Reactors by Atkinson B. Pion Ltd, London. 1974
8. Bioprocess Technology: Fundamentals and Applications, KTH, Stockholm. 2000.
9. Bioprocess Engineering-Kinetics, Mass Transport, Reactors and Gene Expression by Vieth WF. John Wiley & Sons, Inc. 1994.

Theory Paper BT - 203 : Plant Biotechnology**Unit I**

: Conventional plant breeding –Introduction to plant breeding, objectives of plant breeding; Genetic variability and its role in plant breeding, Centers of Origin of crop plants, Methods of reproduction and breeding, Breeding methods in self pollinated, cross pollinated and vegetatively propagated plants; Heterosis and inbreeding depression, genetic basis of inbreeding depression, Genetic, physiological and biochemical basis of heterosis; Exploitation of hybrid vigour; production of hybrids; composite and synthetics; Population improvement

Unit-II

: Introduction to cell and tissue culture as a technique to produce novel plants and hybrids; Tissue culture media (composition and preparation)

Initiation and maintenance of callus and suspension culture, single cell clones.
Organogenesis, somatic embryo genesis, transfer and establishment of cut whole plant in soil
Shoot tip culture; rapid clonal propagation and production of virus free plants; Embryo culture and embryo rescue; Protoplast isolation, culture and fusion selection of hybrid cells and regeneration of hybrid plants, symmetric and asymmetric hybrids, cybrids; Anther, pollen and ovary culture for production of haploids plants and homozygous line; Cryopreservation, slow growth and DNA banking for germ plasm conservation; Green house and green home technology

Unit-III : Plant transformation technology

Basis of tumour formation, hairy root, features of Ti and Ri plasmid,

Mechanisms of DNA transfer, role of virulence genes, use of Ti and Ri plasmid as vector, binary vector; Use of 35S and other promoters, genetic markers, use of reporter genes, reporter genes with introns, use of scaffold attachment regions; Methods of nuclear transformation, viral vectors and their application, multiple gene transfer; Vectors-less or direct DNA transfer and particle bombardment, electroporation, microinjection.

Unit-IV : Application of plant Transformation for productivity and performance:

Herbicides resistance, phosphinothricin, glyphosate, sulfonyl urea, atrazine;

Insect resistance, Bt genes; Non-Bt like protease inhibitors, alpha amylase inhibitors; Virus resistance, coat protein mediated, nucleocapsid genes, diseases resistance; Nematode resistance, abiotic stress, post harvest losses, long shelf life of fruits and flowers; Male sterile lines, bar and barness systems, Chloroplast transformation,

Unit-V : Metabolic engineering and industrial products:

Plant secondary metabolites, control mechanisms and manipulation of phenylpropanoid pathway, shikimate pathway; Alkaloid industrial enzymes, purification strategies, Biodegradable plastics.

Practicals (BT – 206A)

- 1) Preparation of media

- 2) Surface sterilization
- 3) Isolation of explant, induction of callus, establishment and maintenance of callus
- 4) Organogenesis and plant regeneration through clonal propagation.
- 5) Embryogenesis in cultured cell from different explants.
- 6) Micropropagation of banana, citrus Papaya, Sugarcane etc.
- 7) Cell suspension culture from different tissues.
- 8) Embryo culture and embryo rescue of different plant species
- 9) Effect of various growth hormones on cell divisions and cell proliferation
- 10) Isolation, purification and culture of protoplast
- 11) Anther culture pollen culture and production of haploids
- 12) Artificial seed preparation
- 13) Cytological examination of regenerated plants
- 14) *Agrobacterium* culture and selection of transformants.
- 15) Selection of salt tolerance, amino acids analogous resistance through cell cultures.
- 16) Hardening of tissue culture raised plants.

Recommended readings

- 1) Amritrao, P.V.D.A. Evans, W.P.Sharp and Bajaj Y.P.S. (1990) Handbook of Plant Cell Culture volumes I-V, McGraw Hill Publishing Co., New York
- 2) Bhojwani S.S. And Rajidan M.K. (1983). Plant Tissue Culture : Theory and practice.
- 3) Reinert J. and Bajaj Y.P.S. (1977). Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture, By Springer - Verlag, Berlin.
- 4) Grierson, D. and Covey S.N. (1984) Molecular Biology Blakie Publishers, New York.
- 5) Allard R. W. Principle of Plant Breeding.
- 6) Gupta P.K. (1995) Elements of Biotechnology, Rastogi and Company
- 7) Choudhary, Elementary Principle of Plant Breeding.
- 8) Bhojwani S.S. (1991). Plant tissue culture : Application and limitations, Elsevier, Amsterdam.
- 9) Chopra, Plant Biotechnology.
- 10) Dixon R.A. and Gonzales, IRL Press, Plant Cell culture : A Practical Approach.
- 11) Debergh P.C. and Zimmermann (1990) : Micro propogaton : Kluwer, Academic Publication, Dordrecht.

- 12) C.J.Lever : Genome organization and Expression in plants, Plenum press.
- 13) S.D.Kung and R.Wu (1993) Transgenic Plant Vol.1 & 2, Academic press, San Diego.
- 14) Robert B.Goldbergh (1983) : Plant Molecular Biology, Allan R.Liss, Inc, New York.
- 15) K.Lindsey and M.G.K.Jones (1990) : Plant Biotechnology in Agricultural, Prentice Hall, New Jersey.

BT – 204**Elective Paper**

As given in Scheme of examination (in Appendix-B)

BT – 206B**Practical based on Elective Paper****SYLLABUS FOR****SEMESTER III****Theory Paper BT – 301 : Animal Cell Science and Technology****Unit-I**

: Animal Cell

Structure and organization of animal cell; Terminologies in cell culture: Organ, cell, histotypic, organotypic, primary culture and cell line; Primary and established cell line cultures; Biology and characterization of the cultured cells; Principle, Merits and Demerits of Animal cell/tissue culture

Unit-II

: Equipments and Media for Cell Culture; Infrastructure for cell culture:

Equipments, culture vessel and materials; Media for culturing cells and tissues; natural and defined media; Preparation of various tissue culture media ; Chemical, physical and metabolic functions of media constituents; Sterilization of culture media, equipments and apparatus

Unit-III

: Techniques of Cell Culture; Measurement of viability and cytotoxicity

Measurement of growth parameters; Basic techniques of mammalian cell culture *in vitro*; disaggregation of tissue and primary culture, maintenance of cell culture, cell separation; Cell synchronization; Scaling-up of animal cell culture; Cell transformation; *In vitro* culture of oocytes/embryos; Cell/embryo cryopreservation

Measurement of cell death, apoptosis; Cell cloning and micromanipulation; Risks and safety in the animal cell culture

Unit-IV

: Applications of Cell Culture; Cell hybridization: hybridoma and monoclonal antibody production; Stem cell cultures,

embryonic stem cells and their applications
Somatic cell genetics; Organ and histotypic cultures; Three dimensional culture and tissue engineering

Unit-V : Embryo Technology:

Conventional methods of animal improvement : selective breeding and cross-breeding; Embryo biotechniques for augmentation of reproductive efficiency and faster multiplication of superior germplasm; Super ovulation and Oestrus synchronization; Embryo collection, evaluation and transfer; *In vitro* maturation of oocytes; *In vitro* fertilisation and embryo culture; Embryo preservation, micro manipulation and cloning; Somatic cell cloning and embryo sexing

Practical (BT – 304)

1. Preparation of tissue culture medium and membrane filtration.
2. Preparation of single cell suspension from spleen and thymus.
3. Cell counting and cell viability.
4. Macrophage monolayer from PEC and measurement of phagocytic activity.
5. Typsinization of monolayer and subculturing.
6. Cryopreservation and thawing.
7. Measurement of doubling time.
8. Role of serum in cell culture.
9. Preparation of metaphage chromosomes from cultured cells.
10. Isolation of DNA and demonstration of apoptosis of DNA laddering,
11. MTT assay for cell viability and growth.
12. Cell fusion with PEG

Recommended readings

1. Culture of animal cells (3rd Edition) by Freshney R.I. Wiley-Liss.
2. Genes IX by Lewin. Pearson Education International, NJ, USA, 2008.
3. Animal Cell Culture – Practical Approach Edited by John RW. Masters, Oxford.
4. Cell Growth and Division: A Practical Approach edited by Basega R, IRL Press.
5. Animal Cell Culture Techniques edited by Martin Clynes, Springer.
6. Methods in Cell Biology Vol.57, Animal Cell Culture Methods edited by Mather JP and Barnes D, Academic Press.

7. Biotechnology by Satyanarayana U. Books and Allied (P) Ltd, Kolkata, India, 2005.
8. Cell and Molecular Biology (8th edition) by de Robertis EDP and de Robertis EMF (Jr). Lippincott Williams & Wilkins, Philadelphia, 2001.

Theory Paper BT - 302 : Genetic Engineering

UNIT I : Scope of genetic engineering.

Milestones of inventions in Genetic Engineering; DNA chemical synthesis, separation by electrophoresis, various types of agarose used in electrophoresis and PAGE, Denaturing agents used in gel electrophoresis, cloning, control of expression of cloned genes, cloning and patenting of life forms. Guidelines on experimentation in genetic engineering. Guidelines of bio-safety according to WHO (Geneva Convention) and DBT India.

Molecular tools: Polymerase enzymes, Nucleic acid modifying enzymes, nucleic acid ligases, proteases, types of restriction enzymes and their sub types and application, various types of DNA and RNA markers and methods of calculation of molecular weight of nucleic acids.

UNIT II :

Gene cloning vectors: Plasmids: general cloning vector, fusion plasmids, plasmids with bacteriophage promoters, shuttle vectors, phagmids, phages: ? as cloning vector, ?

insertion vectors; ?? replacement vectors. Vectors derived from *Agrobacterium* T1 plasmid, CaMV, Animal viral vectors -SV-40, Vaccinia/Baculo and retro viral cosmids, Artificial chromosomes: yACs, mega yACs: BAC vector; Methods of detection of recombinant; Nucleic acid purification: Different chemicals used in isolation and purification of nucleic acids, Yield analysis: A_{260/280}.

Nucleic acid amplification and its application: History and Method of nucleic acid amplification, Nucleic acid amplification: DNA amplification, RAPD, AFLP, asymmetric PCR, RT-PCR, 5'RACE, 3'RACE, invert PCR, Syber green, hybridization probe amplification, hydrolysis probe amplification (Taq man), Scorpion primers: Basic biochemical requirement of thermal cycler: Solutions, enzymes, buffer, primers, designing of primers, necessary conditions required for designing primers, use of fluorescent dyes and quencher in primers used for real time PCR, annealing temperature, calculation of T_m of primers and optimization of PCR conditions; Instrumentation of thermal cycler:

Instrumentation of general thermal cycler, gradient cycler and Real time cycler; Applications of nucleic acid amplifications in different fields.

UNIT III :

Nucleic acid sequencing; Sequencing of nucleic acids by Maxam & Gilbert method and Sangers method. Requirement of manual sequencing method and automated sequencing methods. Dye primer chemistry and dye terminator chemistry. Various types of gels used for sequencing methods. Pyrophosphatase, analysis of gels. Radio active and non radioactive method of sequencing. Instrumentation of sequencings, Applied biosystem, Licor, and Beckmann sequencing system. Bi directional sequencing method.

Restriction mapping: construction of restriction map, analysis of restriction fragments and its application: cDNA synthesis: mRNA enrichment, digestion using restriction enzymes or mechanical shearing, size fractionation, selection of appropriate vector, preparation of genomic library, use of linkers and adapters, method of screening of library and chromosome walking and chromosome jumping strategies. STS tagging.

Alternative strategies of gene cloning: Two and three hybrid system, cloning differentially expressed genes; Nucleic acid micro array: Construction of DNA chip, use of fluorescent dyes, detection of microarray and application; DNA Profiling: History, DNA profiling based on RFLP method and NA amplification method.

UNIT IV :

Gene regulation: DNA transfection: Northern blot, Southern Blotting, Dot blots, colony hybridization different types of labels used in Northern and Southern blotting methods. Various methods of detection in analysis of blots; S1 mapping, RNase protection assay, Reporter assay: Expression strategy for heterogeneous genes: Vector engineering, and codon optimization, host engineering, in vitro transcription and translation, expression in bacteria, Yeast, insects, mammalian cells, plants and phage display.

UNIT V :

Site directed mutagenesis: Oligonucleotide directed mutagenesis, Mutagenesis with degenerate oligonucleotides, region specific mutagenesis, linker scanning mutagenesis, linker scanning using oligonucleotide directed mutagenesis; Processing of recombinant proteins, purification of recombinant proteins, purification of fusion proteins, *In vitro* refolding and

characterization of rProteins and methods adopted for stabilizations of rProteins; T-DNA- T-DNA and Transposon tagging, identification and isolation of genes through transposon tagging; Transgenic and gene knockout technologies; Targeted gene replacement and chromosome engineering; Gene therapy; Vector engineering; Strategies for gene delivery, gene replacement/ augmentation, gene correction, gene editing, gene regulation and silencing; Ethical values associated with gene therapy, GMO, diagnosis; Molecular markers in crop improvement and inherited human disorders.

Recombinant DNA products/applications: Insulin, hepatitis B antigen vaccine, growth hormones. Molecular farming

Practicals (BT – 304)

1. Bacterial culture and antibiotic selection media. Preparation of competent cells.
2. Isolation of plasmid DNA.
3. Isolation of Lambda phage DNA.
4. Quantitation of nucleic acids.
5. Agarose gel electrophoresis and restriction mapping of DNA.
6. Construction of restriction map of plasmid DNA
7. Cloning in plasmid/phagemid vectors.
8. Preparation of helper phage and its titration
9. Preparation of single stranded DNA template.
10. DNA sequencing.
11. Gene expression in E.coli and analysis of gene product
12. PCR

Recommended readings

1. Molecular Cloning: a Laboratory Manual, J. Sambrook, E.F. Fritsch and T. Maniatis, Cold Spring Harbor Laboratory Press, New York, 2000
2. DNA Cloning: a Practical Approach, D.M. Glover and B.D. Hames, IRL Press, Oxford, 1995
3. Molecular and Cellular Methods in Biology and Medicine, P.B. Kaufman, W. Wu, D. Kim and L.J. Cseke, CRC Press, Florida, 1995
4. Methods in Enzymology Vol. 152, Guide to Molecular Cloning Techniques, S.L. Berger and A.R. Kimmel, Academic Press, Inc. San Diego, 1998
5. Methods in Enzymology Vol 185, Gene Expression Technology,

6. D.V. Goeddel, Academic Press, Inc., San Diego, 1990
7. DNA Science. A First Course in Recombinant Technology, D.A. Mickloss and G.A. Freyer, Cold Spring Harbor Laboratory Press, New York, 1990
8. Molecular Biotechnology (2nd Edn.), S.S. Primrose, Blackwell Scientific Publishers, Oxford, 1994
9. Milestones in Biotechnology. Classic papers on Genetic Engineering, J.A. Davies and W.S. Reznikoff, Butterworth-Heinemann, Boston, 1992
10. Route Maps in Gene Technology, M.R. Walker and R. Rapley, Blackwell Science Ltd., Oxford, 1997
11. Genetic Engineering: An Introduction to gene analysis and exploitation in eukaryotes, S.M. Kingsman and A.J. Kingsman, Blackwell Scientific Publications, Oxford, 1998
12. Molecular Biotechnology - Glick.
13. Recombinant DNA and Biotechnology: Guide to teachers by Helen Kreuzer
14. Academia to biotechnology By Jeffery M Gimble
15. Biotechnology and safety assessment by Jhon A Thomas
16. Methods in biotechnology by Michel Schweizer
17. Bioethics an introduction for the Bioscience By Mephann.

Theory Paper BT-303 : Biostatistics and Bioinformatics

UNIT-I : Introduction to Biostatistics

Sampling techniques; Data collection, tabular and graphical representation of Data; Mean, mode, median, range, variance, standard deviation and standard Error; Test of significance: Z-test, T-test and Chi square test; Probability Distribution: Binomial Poisson and Normal distribution; Correlation and linear regression, Analysis of variance, ANOVA; One-way and two-way classification

Unit-II : Major Bioinformatics Resources

NCBI, EBI, EXPASY The knowledge of various databases Open access bibliographic resources and Literature Sequence and Structure; Databases: Knowledge of the following databases with respect to: organization of data, contents and formats of database entries, retrieval of data using text- based search tools; sources of data (e.g. sequencing projects, individual scientists, patent offices etc.), method for deposition of data to databases. Nucleic acid sequence databases: GenBank, EMBL, DDBJ;

Protein sequence databases: SWISS-PROT, TrEMBL, PIR_PSD; Genome Databases at NCBI, EBI, TIGR, SANGER; Viral Genomes; Archeal and Bacterial Genomes; Eukaryotic genomes with special reference to model organisms (Yeast, *Drosophila*, *C. elegans*, Rat, Mouse) Human, plants such as *Arabidopsis thaliana*, Rice, etc.

Repositories for high throughput genomic sequences: EST, STS GSS, etc. PDB, NDB, CCSD; Derived Databases for bio-molecular sequences

Unit-III : Sequence Analysis

Various file formats for bio-molecular sequences: genbank, fasta, gcg, msf, nbrfpir etc. Basic concepts of sequence similarity, identity and homology, definitions of homologues, orthologues, paralogues.

Scoring matrices: basic concept of a scoring matrix, Matrices for nucleic acid and proteins sequences, PAM and BLOSUM series, principles based on which these matrices are derived. Differences between distance & similarity matrix.

Sequence-based Database Searches: what are sequence-based database searches, BLAST and FASTA algorithms, Various versions of basic BLAST and FASTA, Use of these methods for sequence analysis including the on-line use of the tools and interpretation of results.

Pairwise sequence alignments: basic concepts of sequence alignment, Needleman & Wunsch, Smith & Waterman algorithms for pairwise alignments, use of pairwise alignments for analysis of Nucleic acid and protein sequences and interpretation of results

Multiple sequence alignments (MSA): the need for MSA, basic concepts of various approaches for MSA (e.g. progressive, hierarchical etc.). Algorithm of CLUSTALW and Pileup and their application for sequence analysis (including interpretation of results), concept of dendograms and its interpretation.

Unit-IV : Taxonomy and phylogeny

Basic concepts in systematics, taxonomy and phylogeny; molecular evolution; nature of data used in Taxonomy and Phylogeny, Definition and description of phylogenetic trees and various types of trees,

Sequence patterns and profiles: Basic concept and definition of sequence patterns, motifs and profiles, various

types of pattern representations viz. consensus, regular expression (prosite-type) and profiles; profile-based database searches using PSI-BLAST, analysis and interpretation of profile-based searches.

Protein and nucleic acid sequences properties: e.g. Proteomics tools at the ExPASy server and GCG utilities and EMBOSS

Comparative genomics: Basic concepts and applications: Full Genome alignments: basic concepts, the need for genome alignments

Unit-V : Prediction of protein structure

Secondary structure: Basic principles on which the prediction methods of first, second and third generation are based; algorithms of Chou Fasman, GOR methods; Predicting the secondary structures using these methods and analysis; concepts in measuring the accuracy of predictions (Q3, Segment overlap, Mathew's correlation coefficient etc.)

Tertiary Structure: Theoretical basis of the methods for structure prediction (sequence similarity / identity of target protein with proteins of known structure, fundamental principles of protein folding etc.) and choice of appropriate prediction approach; basic principles and protocol of Homology Modeling; Databases of models; Basic principles for fold recognition, 1D profiles and threading approaches, basic principles of abinitio structure prediction and the broad approaches (what are the hierarchical and enumerative approaches; their general outline),

Protein structure comparison and classification: classes, folds; the concepts in 3D structure comparison, purpose of structure comparison, algorithms such as FSSP, VAST and DALI

Practical (BT – 304)

1. Computer oriented statistical techniques.
2. Preparations of charts / graphs using computers.
3. Data Retrieval System: Entrez and SRS.
4. Pairwise sequence Alignment methods: Dynamic Programming and Dot Plot/Analysis
5. Multiple sequence alignment using ClustalW / ClustalX
6. Phylogenetic analysis of protein and DNA sequences by PhyIip and MEGA

7. Analysis of multiple aligned sequences for their physico – chemical properties using GenlDoc.
8. Search for active site / probase/ blocks in given sequence using on line / offline softwares.
9. Determination of secondary structure of amino acid sequence using SOPM / GOR/ Chou Fasman other softwares.
10. Visualization of molecular structure of protein / Nucleic acid molecule using Rasmol / Cn3
11. Tertiary Structure prediction methods.
12. Full Genome Alignment.

Recommended readings

1. Baxevanis A., Ouellette F.B.F. (Eds.) Bioinformatics: a practical guide to the analysis of genes and proteins John Wiley and Sons, New York
2. Bishop M.J., Rawlings C.J. (Eds.) DNA and protein sequence analysis. A Practical approach IRL Press, Oxford Lesk A.M. (Ed.) Computational molecular biology. Sources and methods for sequence analysis. Oxford University Press, Oxford
3. Structural Bioinformatics, Philip E. Boume, Helge Weissig (Editors), John Wiley & Sons
4. Protein Structure Prediction: Bioinformatic Approach, I.F. Tsigelny, International University Line
5. Introduction to Protein Architecture: The Structural Biology of Proteins, Arthur M. Lesk, 2001, Oxford University Press
6. Protein Structure Prediction: Methods and Protocols, David M. Webster (Editor), 2000, Humana Press
7. Introduction to Protein Structure, Carl-Ivar Branden, John Tooze, Garland Publishing
8. Handbook of Comparative Genomics: Principles and Methodology, Cecilia Saccone, Graziano Pesole, 2003, Wiley-Liss
9. Sequence - Evolution - Function: Computational Approaches in Comparative Genomics, Eugene V. Koonin, Michael Y. Galperin, 2002, Kluwer Academic Publishers
10. Genome Analysis: A Laboratory Manual, 4 volumes, Bruce Birren, et al. (Editors), Cold Spring Harbor Laboratory Press
11. Bioinformatics: Sequence and Genome Analysis by *David W. Mount*
12. Bioinformatics : Sequence, Structure, and Databanks : A Practical Approach (Practical Approach Series by Des Higgins (Editor), Willie Taylor (Editor)

13. Introduction to Bioinformatics by Teresa K. Attwood, David J. Parry-Smith
14. Bioinformatics : A Practical Guide to the Analysis of Genes and Proteins, 2nd edition by Andreas Baxevanis (Editor), B.F.Francis Ouellette (Editor)

SYLLABUS FOR

SEMESTER IV

Theory Paper BI-401 : Environmental Biotechnology

UNIT I : Environment: Basic Concept

Environment pollution: Types of pollution, Measurement of pollution, Microbial quality of Air, Aerosol, Hospital site, Sewage treatment site, Industrial process and solid waste dumping site, Carcinogenic chemicals and odour in air, Methods of control through Biotechnology, Green belt development; Water: Different sources of water and their quality, Nitrate Fluorides, Heavy metal in water, Methods of its removal Microbial corrosion and its control methods

UNIT II :

Waste and its generation: Collection methods of sewage and industrial waste and its characterization; Waste water treatment: Physical, chemical and biological, Principles of biological waste treatment process; Aerobic process: Activated sludge, Oxidation ditch, Trickling filter, Biotowers, Rotating disc, Oxidation pond, Extended aeration methods

Anaerobic Process: Anaerobic digestion, Anaerobic filters, Up-flow anaerobic sludge blanket (UASB), Biomethanation process; Treatment scheme of Dairy, Distillery, Tannery, Sugar, Fertilizers; Refinery, Chemical and Antibiotic waste. Measurement of water pollution. Waste microbiology of aerobic and anaerobic treatment processes. Recycle and Reuse of waste water.

UNIT III :

Xenobiotics in environmental. Oil pollution and its methods of control, Biodegradation of Hydrocarbons, Substituted hydrocarbons, Surfactant, Pesticides, Lignin, Tannin, Synthetic dyes, Bioremediation of contaminated soil and waste land, Mine spoil dumps, Biopesticides and integrated paste management, Bioaccumulation and their types.

Unit IV :

Solid waste: Industrial and domestic, characterization of solid waste and management (composting, Vermiculture and Anaerobic processes)

Hazardous Waste: Definition, collection, characterization and treatment process (Hospital waste, Sludges from chemical industries containing toxic waste); Ozone

depletion, UV-6 green house effect, Acid rain, Global warming their impacts and Biotechnological approaches for management

- UNIT V :** Bioleaching, Biofertilizer, Eutrophication, Sustainable agriculture and environment (AMF, ECM, PGPRs, PSB), with special reference to agriculture; Biosafety, Biological warfare, Carcinogenicity, Health risk and Environmental toxicity, Biodiversity and its methods of conservation, Bioluminescence.

Practicals (BT-404)

1. Detection of coliforms for determination of the purity of potable water.
2. Determination of total dissolved solids of water
3. Determination of dissolved oxygen concentration of water sample
4. Determination of biological oxygen demand (500) of n sewage sample
5. Determination of chemical oxygen demand (COD) of sewage sample.
6. Determine the efficiency of removal of air pollutant using fibrous air filter.
7. Isolation of xenobiont degrading bacteria by selective enrichment technique
8. Test for the degradation of a aromatic hydrocarbons by bacteria
9. Survey of degradative plasmids in microbes growing in polluted environment
10. Effect of Sulphur dioxide on crop plants
11. Estimation of heavy metals in water/soil by Atomic absorption spectrophotometry,
12. Estimation of nitrate in drinking water.
13. Role of microorganisms in elevation of heavy metal induced stress I plants.

Recommended readings

1. Chatterji, 2004 Introduction to Environmental Biotechnology, Prentice-Hall of India.
2. Sincero and Sincero, 2004 Environmental Engineering : A Design Approach, Prentice-Hall of India.
3. Abbasi and Abbasi, 2004 Renewable Energy sources and their Environmental Impacts. Prentice-Hall of India.

4. Gilbert Masters. 2004. Introduction to Environmental Engineering and Science, Second addition, Prentice-Hall of India.
5. Marshall Laird, 1990. Safety of Microbial Insecticides, International Books.
6. Kumar and Arvind 2004, Environmental Biotechnology, Daya Publishing.

Theory Paper BT-402 : Industrial Biotechnology

Unit I : Fermentation products:

Dairy products: Milk processing - Cheese - principles of cheese making: Cheddar Cheese, Swiss Cheese, Surface ripened Cheeses; Mold ripened Cheeses. Cottage and Indian Channa cheese. General principles of manufacture of Yogurt, acidophilus milk, Kefir, Koumiss Fermented foods: Soy sauce, Miso, Suifu, Natto, Idli, fermented fish products, Sauer Krant, pickles, fermentation of Olives, fermented sausages; Production of distilled beverage alcohol, wine, brandy and beer.

Unit II : Biopesticide and biofertilizers

Biopesticides: Biological control, plant biopesticides or botanical pest control (BPC), Recent interest in *Bt*-biopesticides, Nuclear polyhydrosis virus (NPV), Baculoviruses, Trichoderma and Trichogramma as biopesticides, Genetically engineered bacteria as biopesticide, Impact of biopesticides in sustainable agriculture.

Biofertilizers: Principles and objectives of Biofertilizers and Integrated Nutrient Management (INM), Need for integrated nutrient management, Components of integrated nutrient management: Chemical fertilizers, organic fertilizers, legumes as a green manures, vermicompost for sugarcane, organic Farming and organic Food.

Unit III : Bioprospecting:

Introduction: Biodiversity prospecting; Biochemical resources from plants and fungi, natural products: the role of natural products in drug discovery, natural products as modern drugs; Prospecting for New Compounds from Plants particularly from Melghat forest: Discovery of novel compounds, Screening of traditional knowledge-based herbal drugs, Preparation of crude compounds, Isolation of pure compounds, bio-assay guided isolation, high throughput screening of extracts.

Bioprospecting from microbes (Actinomycetes, Bacteria,

fungi) with special reference to marine actinomycetes, endophytes and metagenomics by products. Anticancer, antiviral, antibacterial, antifungal, anti-diabetics from microbial origin.

Unit IV : **Industrially important products**

Industrial production of alcohol, Acetone, Citric acid, Gluconic acid, Acetic acid, lactic acid; Production of polysaccharides, Penicillin, Xanthan; Industrial enzymes (proteases, pectinases, cellulases and lipases)

Unit V : **Bionanotechnology and industrial applications**

Introduction to bionanotechnology and overview of nanoscale materials; effect of length scale on properties; challenges and opportunities associated with biology on the Nanoscale; top-down and bottom-up approach, methods of nanoparticle synthesis, its characterization and analysis of nanoparticles by different techniques such as UV-Visible spectroscopy, NMR, SEM, TEM, X-RD, FTIR. Synthesis of Nanoparticles by Biological system, Extracellular biosynthesis with a case study of silver and gold nanoparticles, Intracellular biosynthesis case by bacteria.

Applications of bionanotechnology in various fields.

Practicals (BT-404)

1. Lab scale production of alcohol and acetic acid.
2. Production of amylase/ pectinase and cellulase.
3. Preparation and formulation of microbial biopesticide (bacteria, fungi and viruses)
4. Screening of microbes for enzyme/metabolites production.
5. Production of metal nanoparticles using microbes.
6. Estimation of lignocellulose degradation.
7. In vitro evaluation of medicinal plants against pathogenic microbes.
8. Effect of mycorrhizal fungi on growth promotion of plants.
9. Production of microbial fertilizers (Rhizobium, Azotobacter and AMF²).

Recommended readings

1. Modern Food Micro-Biology by J.M.Jay, (1986), Van Nostrand Reinhold company, New York.
2. Comprehensive Biotechnology Vol. 1-4 : M.Y. Young (Eds.), Pergamon Press.

3. Biotechnology : A Text Book of Industrial Microbiology : T.D. Brock, Smaeur Associates, 1990.
4. Industrial Microbiology : L.E. Casida, Willey Eastern Ltd., 1989.
5. Industrial Microbiology : Prescott & Dunn, CBS Publishers, 1987.
6. Bioprocess Technology- fundamentals and applications, S O Enfors & L Hagstrom (1992), RT, Stockholm.
7. Biotechnology, Economic & Social Aspects : E.J. Dasilva, C Ratledge & A Sasson, Cambridge Univ. Press, Cambridge.
8. Biotechnology - a hand book of industrial microbiology : W. Crueger and A. Crueger.
9. Microbial Biotechnology : A. N. Glazer and H. Nikaido.

BT – 403 Elective papers

As given in Scheme of examination as per Appendix-D

BT-404 Practical based on Elective Paper

BT-405 Project

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