SHIVAJI UNIVERSITY

KOLHAPUR

DEPARTMENT OF BIOTECHNOLOGY

M. Sc. PART -II

Revised Syllabus for Credit System

(WITH EFFECT FROM ACADEMIC YEAR 2015-2016)

SEMESTER-III

GE 341: Genetic Engineering

FT 341: Fermentation Technology-I

IM 341: Immunology

BT 341: Plant Biotechnology

LC BT 341: Laboratory Course V

LC BT 342: Laboratory Course VI

SEMESTER-IV

AT 441 : Animal Tissue Culture

AGP 441 : Advances in Genomics and Proteomics

APB 441 : Advances in Plant Biotechnology

IOM 441 : Industrial Organization and Management

OR

NB 441 : Nanobiotechnology

LC BT 441: Laboratory Course VII

LC BT 442: Laboratory Course VIII (Project Work)

Work load for M. Sc II

(Each Semester)	Theory	Practicals
	16 hrs	16 hrs
Seminars	2 hrs	(for 1 batch)
Oral Exam	2 hrs	
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	20 hrs	

SEMESTER-III
GE 341: Genetic Engineering
IM 341: Immunology
PB 341: Plant Biotechnology
LC BT 341: Laboratory Course V
LC BT 342: Laboratory Course VI

SEMESTER-IV
AGP 441: Advances in Genomics and Proteomics
APB 441: Advances in Plant Biotechnology
LC BT 441: Laboratory Course VII
LC BT 442: Laboratory Course VIII (Project Work)

Following courses offered by Dept. of Biotechnology are optional or choice based. Instead of these courses, students can opt for courses offered by other departments as part of Choice Based Credit System (CBCS pattern).

Sem I BSI 141: Biostatistics and Bioinformatics with Computer Orientation

Sem. III: FT 341: Fermentation Technology-I

Sem. IV: AT 441: Animal Tissue Culture
IOM 441: Industrial Organization and Management
NB 441 : Nanobiotechnology

Department of Biotechnology will offer following three courses as part of CBCS pattern

Sem III: PB 341: Plant Biotechnology (pre-requisites: MB 241, GE 341)

Sem. IV: AGP 441: Advances in Genomics and Proteomics (pre-requisites: MB 241, GE 341)
APB 441: Advances in Plant Biotechnology (pre-requisites: PB 341)

These choice based courses are open to be opted by students studying M. Sc Biochemistry, Microbiology, Botany, Zoology, Environmental Biotechnology.

(LS141 represents: LS: Course name, 1: Semester, 4: credit allotted to the course, 1: Chronological order within that category)

Core Theory courses: 12 x 4 = 48 credits

Core Practical courses: 6 x 4 = 24 credits

SEMESTER III

GE 341: Genetic Engineering **(60)**
(Prerequisite: MB 241)

UNIT-I **(15)**

DNA & BASICS OF RECOMBINANT DNA TECHNOLOGY

Structure of DNA: A-,B-,Z-, and triplex DNA, measurement of properties, spectrophotometric, CD, AFM, and electron microscope analysis of DNA structure. Restriction analysis: Types of restriction enzyme, Type I, II and III, restriction modification systems, type II restriction endonucleases and properties, isoschizomers and neoschizomers, mcr/mrr genotypes, Cohesive and blunt end ligation, linkers, adaptors, homopolymeric tailing. Labeling of DNA: Nick translation, random priming, radioactive and non-radioactive probes, use of Klenow enzyme, T4 DNA polymerase, bacterial alkaline phosphatase, polynucleotide kinase. Hybridization techniques: Northern, Southern and Colony hybridization, Fluorescence *in situ* hybridization Restriction maps and mapping techniques, DNA fingerprinting, chromosome walking & chromosome jumping DNA-Protein Interactions: Electro mobility shift assay, DNase I footprinting, methyl interference assay

UNIT -II **(15)**

CLONING VECTORS

Gene Cloning Vectors: Plasmids, bacteriophages, Cloning in M13 mp vectors, phagemids, Lambda vectors; insertion and replacement vectors, EMBL, λDASH, λgt10/11, λZAP etc. Cosmid vectors. Artificial chromosome vectors (YACs, BACs), Animal Virus derived vectors-SV-40, vaccinia/bacculo & retroviral vectors. Expression vectors; pMal, GST, pET-based vectors. Protein purification; His-tag, GST-tag, MBP-tag etc. Restriction proteases, intein-based vectors. Inclusion bodies, methodologies to reduce formation of inclusion bodies. Baculovirus and pichia vectors system

UNIT- III **(15)**

CLONING METHODOLOGIES

Insertion of Foreign DNA into Host Cells: Transformation, Transfection: Chemical and physical methods, liposomes, microinjection, macroinjection, electroporation, biolistics, somatic cell fusion, gene transfer by pronuclear microinjection, Plant transformation technology: Basis of tumor formation, hairy root, features of Ti and Ri plasmids, mechanism of DNA transfer, role of virulence genes, use of Ti and Ri as vectors. Cloning and expression in yeasts (Saccharomyces, Pichia etc.), animal and plants cells, methods of selection and screening, cDNA and genomic cloning, expression cloning, jumping and hopping libraries, southwestern and far western cloning, yeast two hybrid system, phage display, Construction of cDNA libraries in plasmids and

screening methodologies, Construction of cDNA and genomic DNA libraries in lambda vector. Principles in maximizing gene expression, Site-directed mutagenesis.

UNIT- IV **(15)**

PCR AND ITS APPLICATIONS

Primer design, Fidelity of thermostable enzymes, DNA polymerases, multiplex, nested, reverse transcriptase , real time PCR, touchdown PCR, hot start PCR, colony PCR, cloning of PCR products, T-vectors, proof reading enzymes, PCR in gene recombination, deletion, addition, overlap extension, and SOEing, site specific mutagenesis, PCR in molecular diagnostics, viral and bacterial detection, PCR based mutagenesis.

Sequencing methods: Enzymatic DNA sequencing, Chemical sequencing of DNA, principle of automated DNA sequencing, RNA sequencing.

Chemical Synthesis of oligonucleotides. Gene silencing techniques: Introduction to siRNA and siRNA technology, micro RNA, construction of siRNA vectors, principle and application of gene silencing. Gene knockouts and Gene Therapy: Creation of knock out mice, disease model, somatic and germ-line therapy in vivo and ex-vivo, suicide gene therapy, gene replacement, gene targeting Other applications: Transgenics, Genome projects and their implications, application in global gene expression analysis. Applications of recombinant DNA technology in medicine, agriculture, veterinary sciences.

Suggested readings

1. Sambrook J, Fritsch E. F. and Maniatis (1989) Molecular cloning, vol. I, II, III, II nd edition, Cold spring harbor laboratory press, New York.
2. DNA Cloning : A practical approach D.M. Glover and D.B. Hames, RL 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 Guide to Molecular Cloning Techniques, Vol. 152 S.L. Berger and A. R. Kimmel, Academic Press Inc, San Diego, 1996
5. Methods in Enzymology Gene Expression Technology, Vol. 185D. V. Goedel, Academic Press Inc, San Diego, 1990
6. DNA Science: A First Course in Recombinant Technology, D. A. Mickloss and G. A Freyer, Cold Spring Harbor Laboratory Press, New York, 1990
7. Molecular Biotechnology, 2nd Ed. S. B. Primrose, Blackwell Scientific publishers, Oxford, 1994
8. Milestones in Biotechnology, Classic Papers on Genetic Engineering, J. A. Davis and W. S. Reznikoff, Butterworth-Heinemann Boston 1992
9. Route Maps in Gene Technology, M. R. Walker, and R. Rapley, Blakwell Science, Oxford, 1997
10. Genetic Engineering : An Introduction to Gene Analysis and Exploitation in Eukaryotes, S. M. Kingsman, Blackwell Scientific Publications, Oxford, 1998

FT 341: Fermentation Technology-I (60)
(Prerequisite: LS 141, TB 241, GE 341)

UNIT I (15)

Upstream processing, microbial cell growth, kinetics and stoichiometry, various Methods for growth measurement, strain improvement by mutation, genetic engineering etc. Over production of metabolites, alternative carbon and nitrogen sources and their composition. Development of innocula for industrial fermentation, design of industrial production media. Alternate metabolic routes for utilization of carbon sources with their regulation and inter-linkage especially for glucose and hydrocarbons, preservation and maintenance of microbes.

UNIT II (15)

Fermentation, Design of fermenter, Construction materials, Various sterilization techniques for solid, liquid and gases, Aeration and agitation, foam, Auxillary equipments. Control of various parameters – online and offline monitoring, rheological properties of fermenter, role of computer in fementer operation,

UNIT III (15)

Batch, fed-batch and continuous fermentation. Effluent treatment, scale up and scale down. Types of fermentors, solid state fermentation, process economics, fermentation economics.

UNIT IV (15)

Downstream Processing, Principle, methodology, instrumentation an applications of cell homogenization techniques liquid-liquid extraction centrifugation, filtration, , distillation, ultrafiltration, precipitation, adsorption chromatography, ion exchange chromatography, gel filtration and affinity chromatography in clarification, concentration, isolation and purification of various metabolites from fermented media

Suggested Readings

1. Moo-Young M. ed. (1985) Comprehensive Biotechnology vol: I & II, Pergamon Press N.Y.
2. Ratledge C and Kristiansen B. eds. (2001) Basic Biotechnology 2nd ed. Cambridge Univ Press Cambridge.
3. Old R.W and Primose S.D (1995) Principles of Gene Manipulation 5th ed. Blackwell Scientific Pub. Oxford.
4. Bailey J.E and Ollis D.F. (1986) Biochemical Engineering Fundamentals 2nd ed. McGraw Hill Book Company, N. Delhi.
5. Aiba S, Humphrey A. E. and N. F. Millis (1973) Biochemical Engineering, 2nd Edition University of Tokyo Press, Tokyo, Japan.
6. Stanbury P.F., Whitaker A, and Hall S.J. (1997) Principles of Fermentation Technology 2 nd ed.Aditya Books Pvt. Ltd, N.Delhi.

7. Mukhopadhaya S.N. (2001) Process Biotechnology Fundamentals.Viva Books Pvt. Ltd. N.Delhi.
8. Rehm H.J and Reed G. (1985) Biotechnology vol. I & II. VCH, Basel.
9. Stainer R. Y. Ingrahm J. L., Wheelis M. L. and Painter P. R. (1987) General Microbiology 5th Edition, Macmillan Press Ltd. London.

IM 341: Immunology **(60)**
(Prerequisite: B Sc Life Science)

UNIT I **(15)**

Immunology – fundamentals and anatomy of immune system, Immunity – Innate and acquired immunity, components of innate and acquired immunity. Antigen, haptens, adjuvants, mitogens. Antibodies – structure, functions. The anatomy of the immune response: - Cells and organs of immune system. Regulation of immune response – Humoral and Cell mediated response.

UNIT II **(15)**

Immunity to infection, antigen processing and presentation, MHC, complement system. Bacterial, viral, protozoal and parasitic infections with reference to (Diphtheria, influenza virus, malaria and helminthes) with specific representative examples of each group. Vaccines – Active and passive immunization, DNA vaccines, multivalent subunit vaccines, synthetic peptide vaccines.

UNIT III **(15)**

Clinical immunology. Hypersensitivity: Type I, II, III, and IV reactions. Autoimmunity: organ specific and systemic autoimmune diseases, treatment of autoimmune diseases. Transplantation and tumor immunology: graft rejection, tissue typing, immunosuppressive therapy and clinical transplantation. Tumor antigens,cancer immunotherapy immunodeficiency diseases - Phagocytic, humoral, cell mediated deficiencies and SCID. AIDS- causes, syndrome, diagnostic tools, treatment and development of vaccine

UNIT IV **(15)**

Immunotechnology, antigen antibody interactions: principles, types and applications of agglutination, precipitation, complement fixation, viral neutralization, immunodiffusion, immunoelectrophoresis, ELISA and RIA. Monoclonal antibodies – Hybridoma technology and various cellular technologies. Automation in immunological techniques – auto analyzers used in immunology, FACS etc.

Suggested readings

1. Kuby : Immunology; RA Goldsby, Thomas J. Kindt, Barbara A. Osborne.
2. Immunology by Roitt I. M., Brostoff J. and Male D. Gower medical publishing London.
3. Fundamentals of immunology 4th ed., Paul 1999, Lippencott Raven.

BT-341: Plant Biotechnology **(60)**
(Prerequisite: B Sc Life Science)

UNIT-I **(15)**

Plant physiology and its significance in agriculture; physical properties and chemical constitution of protoplasm, concept of diffusion and osmosis, plant cell water relation – imbibition, absorption and translocation of water and nutrients, transpiration, guttation, Photosynthesis-modern concept and the factors affecting photosynthesis, nitrogen fixation

UNIT- II **(15)**

Introduction to plant biotechnology: history, concept of totipotency, heterogeneity, cytodifferentiation, preparation of explant. Incubation systems: culture room, green house and shade house, advantages and limitations of each system. Tissue culture media: general introduction, composition, sterilization. Role of macro and micro nutrients in plant growth and effects of their deficiency. Plant Hormones: types, role in plant development & mechanism of action.

UNIT III **(15)**

Initiation, maintenance and importance of callus culture, suspension culture and single cell culture, types and applications of single cell culture, organ culture, protoplast culture and its applications, isolation and types of protoplasts fusion, seed dormancy and germination, somatic embryogenesis its types and applications, encapsulation and production of synthetics seeds, development of somatic hybrids to overcome the incompatibility barriers.

UNIT IV **(15)**

Anther culture and production of haploid plants and homozygous lines, embryo culture and embryo rescue, pollen, ovary culture and their applications, germ plasm preservation. Micropropagation: principle, vegetative regeneration by-shoot tip, meristem, axillary and adventitious shoot initiation, organogenesis and production of pathogen free plants, hardening of tissue cultured plants, industrial applications of micropropagation technique.

Suggested Readings

1. Razdan, M. K, An introduction to Plant Tissue Culture 2nd edn. Science Publishers, USA.
2. Bhojwani, S. S. and M. K. Razdan 1996.Plant Tissue Culture:Theory and Practice, Elsevier Pub.
3. Chrispeels, M. J. 2002. Plant Tissue Culture:Genetical Aspects. Jones and Bortlett Publishers, International.
4. Chopra V. L. et al 1999. Applied Plant biotechnology. Science Publishers Inc.
5. Verpoorte, R. and A.W. Alfermann (Eds) 2000.Metabolic Engineering of plant secondary metabolism, lower Academic Publisher.

LC BT 341: Laboratory Course V (60)

(Prerequisite: LC BC 141, LC BC 142)

1. Estimation of IAA
2. Determination of activity of enzyme IAA oxidase
3. Estimations amino acids (arginine and histidine)
4. Induction of beta galactosidase in *E. coli.*
5. Study of mutations by Ames test.
6. Assay of antibiotics and demonstration of antibiotic resistance.
7. Isolation of organic acid and amine producers and biochemical characterization of isolated microbes.
8. One step growth curve of coliphage.
9. Isolation of Streptomycin resistant mutants.
10. Transduction .
11. Conjugation.
12. Isolation of genomic DNA

LC BT 342: Laboratory Course VI (60)

(Prerequisite: LC BC 141, LC BC 142)

1. Plant tissue culture
2. Preparation of Media
3. Surface Sterilization
4. Organ Culture
5. Callus Culture, organogenesis
6. In vitro rooting and acclimatization
7. Protoplast isolation and culture
8. Anther Culture/ Production of haploids
9. Cytological examination of regenerated plants
10. Agrobacterium culture, selection of tranformants, GUS assay.
11. Synseed preparation
12. Immunological techniques
13. Double diffusion.
14. ELISA
15. Antibody capture
16. Antigen capture
17. Dot ELISA
18. Precipitin Reaction - Ring test- Immunodiffusion.
19. Immunofluorescence
20. Latex Agglutination
21. Radial Immunodiffusion.
22. Rocket Immunodiffusion.

Suggested Readings

1. Practical Biochemistry : An Introductory Course by Fiona Frais.
2. Methods in Enzymology Vol. I by S.P.Colowick and N.O.Kaplan eds.
3. Basic Biochemical Methods 2nd ed by R.R.Alexander and J.M.Griffith
4. Biochemical Methods 2nd ed. by S.Sadasivam and A. Manickam.
5. Hawk's Physiological Chemistry ed. by Bernard L Oser.
6. A Textbook of Practical Biochemistry by David Plummer.
7. Laboratory Manual in Biochemistry by S. Jayaraman.

SEMESTER IV

AT- 441: Animal Tissue Culture (60)
(Prerequisite: B Sc Life Science)

Unit I (15)
Animal cell culture: Introduction, applications and limitations. Laboratory organization: Design of ATC laboratory. Equipments used in animal tissue culture: Laminar Airflow Hoods, CO_2 incubators, microscopes, refrigerators and deep freezers. Aseptic techniques in animal tissue culture.

Unit II (15)
Animal tissue culture media: Physical and nutritional requirements of cells, growth media and cell culture growth kinetics, different types of basal salt solution (BSS), minimal essential medium (MEM), antibiotic media, serum dependent defined media, serum independent defined media (for specific cell types), pH, bulk ions, trace ions, CO_2, O_2 tension, ascorbic acid, vitamins and coenzymes. Types of contaminations in animal tissue culture. Protocols for routine characterization of cell lines.

Unit III (15)
Types of primary cells: epidermal, corneal, cervical, tumors cells, cerebellar, chondrocytes, osteoblasts, melanocytes and bone marrow cells. Basic techniques in animal tissue culture: Open and closed cell cultures, primary cell culture – isolation and separation of cells, viable cell count, maintenance of stock and regular cultures, antibiotic free stock culture. Types of animal cell cultures: monolayes, suspension, clonal culture, mass culture, micro carrier culture (monolayer), stem cell culture (ESC).

Unit IV (15)
Cell fusion methods: Techniques involved in cell fusion, hybridoma cells: definition; preparation; properties and use of hybridoma technology, mini cells, micro cells and anucleated cells in fusion and their applications. Tissue engineering: capillary culture units; Techniques for culturing differentiated cells: reconstitution basement membrane rafts, feeder layers. Uses of animal cell culture technology: Mutant cell preparation; evaluation of chemical carcinogenicity and malignancy testing; metabolite production using animal cells and applications of pluripotent stem cells.

Recommended Books:

1. Culture of Animal Cell: R. I. Freshney (Wiley-Liss)
2. Animal Cell Culture-Practical Approach: R. W. Jhon (Masters Oxford)
3. Biotechnology: U. Satyanarayana (Books & allied Pvt. Ltd.)
4. Methods in Cell Biology (Vol. 57)- Animal Cell Culture Methods: J. P. Mathon and D. Barnes (Eds) (Academic Press).
5. Mammalian Cell Biotechnology: A Practical Approach (1991): Butler, M. (IRL Press, Oxford)

AGP 441: Advances in Genomics and Proteomics (60)
(Prerequisite: BC 142, MB 241 and GE 341)

UNIT I (15)
ADVANCE NUCLEIC ACIDS TECHNIQUES

Agarose gel electrophoresis, PFGE, Principles of PGFE, instrumentation, types and applications of PFGE. DGGE, Principles of DGGE, types and applications of DGGE, RT PCR, Real time PCR, principle of Real time PCR, types and application of Real time PCR, (quantitative and qualitative), Designing Primers and probes for RT PCR, types of probes and their chemistries. RNA interference and gene silencing (si-RNA, mi-RNA) technology, Mi RNA. Various blotting techniques.

UNIT II (15)
DNA SEQUENCING TECHNOLOGIES

DNA sequencing technologies: Different chemistries in DNA sequencing, Next Generation sequencing (Sanger's sequencing, SOLiD, Pyrosequencing), application of next generation sequencing (NGS), genomic library, EST library, cDNA library, Whole genome sequencing, Introduction to the concept of Transcriptomics and Metagenomics, Applications of Transcriptomics and Metagenomics.

UNIT III (15)
PHYLOGENETIC ANALYSIS

Evolution, elements of phylogeny, methods of phylogenetic analysis, Phylogenetic tree of life, comparison of genetic sequence of organisms. Identification of microbial isolates by 16S rDNA amplification and sequencing, methods of study of unculturable microbial flora from environmental sample, 16S rDNA library, 16S rRNA library, Ribosomal Database Project (RDP), Introduction to phylogenetic analysis tools, Concept of operational taxonomic unit (OTU)/ phylotypes, rarefaction curve, DOTUR, MOTHUR, MEGA, Phylip, PAUP, ClustalW. DNA based molecular markers technologies: RAPD, RFLP, AFLP, SCAR, SSR, ISSR, t-RFLP, The principles and applications of DNA based molecular markers.

UNIT IV (15)
MICROARRAYS AND PROTEOMICS

Concept of microarrays; spotted arrays, oligonucleotide arrays, designing the experiment, microarray design, microarray experimentation, Applications of microarray technology. Chromatography: gel permeation, adsorption (ion exchange, affinity), partition, HPLC, protein purification. 2-D analysis and Maldi-Tof in Proteomics, Mass spectroscopy for protein analysis, MALDI-TOF, Electrospray ionization, Tandem mass spectroscopy (MS/MS) analysis; tryptic

digestion and peptide, fingerprinting (PMF), Protein Micro array in protein expression, profiling and Diagnostics.

Suggested readings

1. Bernard R. Glick and Jack J. Pasternak, Molecular Biotechnology: Principles and Applications of Recombinant DNA.
2. Introduction to Bioinformatics, (Atwood, T. K. and Parry-Smith, D. J).
3. An introduction to Computational Biochemistry. (C. Stain Tsai, A JohnWiley and Sons, Inc., publications).
4. Developing Bioinformatics Computer Skills. (Cynthia Gibas and Per Jambeck).
5. Bioinformatics Methods and Applications Genomics, Proteomics and Drug Discovery. (Rastogi S. C. Mendiratta, and Rastogi P.)
6. NCBI Web site: http://www.ncbi.nlm.nih.gov
7. Molecular Cloning by Sambruk and Russel (Maniatis)

APB 441: Advances in Plant Biotechnology 60)

(Prerequisite: BT 341)

UNIT I (15)

Plant protection: Diseases of field, vegetable, orchard and plantation crops of India and their control; causes and classification of plant diseases; principles of plant disease control biological control of diseases; seed health testing, Integrated pest management-concepts and components; host plant resistance-biological control of insect pests; genetic manipulation of insects for their control; pesticides, their formulation, classification and safe use; behavioural methods; use of computer modeling in pest and disease outbreak; insect growth regulators; biotechnological approaches in IPM;

UNIT II (15)

Agricultural microbiology: Contributions of Beijerinck and Winogradsky-Role of microbes in carbon and nitrogen cycles-Influence of Rhizosphere on soil microorganism-various types of nitrogen fixing microorgranism-Production of bacterial biofertilizers: Rhizobium, Azospirillum, Phosphobacteria etc.- Fungal biofertilizers; Ecto- and Endomychorizae- Azolla and BGA-Method of application for different biofertilizers, biopesticides.

UNIT III (15)

Concept of secondary metabolites, their applications in agriculture and health industry. *In vitro* production of secondary metabolites: introduction to secondary metabolism, significance of cell differentiation, selection, downstream processing, influence of culture conditions on accumulation of secondary metabolites, immobilization of cells for enhanced production of secondary products, biotic and abiotic elicitation. Different techniques involved in isolation, purification and characterization of useful secondary metabolites from cultured cells.

UNIT IV (15)

Transgenic techniques in plant biotechnology: introduction of foreign gene into plants, basics of tumor formation, hairy root culture and its uses, features of Ti & Ri plasmid, mechanism of DNA transfer, role of virulence gene, use of reporter gene, multiple gene transfers, vector less or direct DNA transfer, particle bombardment, electroporation, microinjection, chloroplast transformation. Applications of plant transformation for enhancing resistance to pests, productivity & performance, nutritional value, modification of ornamental plants, bioengineered food, edible vaccines, plantibodies, biopharming.

Suggested Readings

1. Slater, Plant Biotechnology, OUP
2. H.E Street(ed): Tissue culture and Plant science, Academic press,London, 1974
3. M.K.Sateesh, Biotechnology-5 Animal cell biotechnology Immune biotechnology Plant biotechnology New Age Int Publishers,2003
4. Concepts in Biotechnology D. Balasubramaniam, Bryce, Dharmalingam, Green, Jayaraman
5. Univ. Press, 1996

IOM- 441: Industrial Organization and Management (60)
(Prerequisite: B. Sc. Life Science)

UNIT I (15)

Principles of Management, Management: meaning and importance, Principles of Management. Functions of Management. Planning: meaning and importance, steps in the process of planning, Decision-making. Organizing: process of organizing, types of organizational structures, informal organizations. Directing, Communication process, barriers to effective communication, Mediation- theories of Motivation, Leadership styles. Controlling- Control techniques.

UNIT II (15)

Functional areas of Management, Production Management-Objectives, Importance, Productivity. Purchase and Stores management. Methods of purchasing, Selection of vendors ,inspection and quality control, inventory control, methods of inventory –FIFO, FIFO. Stores management. Quality Management: TQM, Quality management, ISO Systems. Work Study. Work Measurement, time and motion study

UNIT III (15)

Marketing Management, Concepts of selling, marketing, market research, pricing methods, penetration and skimming pricing, physical distribution, methods, advertising and sales promotion. Personnel Management, Manpower planning, sources of recruitment, selection and training of staff, performance appraisal Employee Welfare. Financial Management- Objectives, Importance, Cost control , BEP tech.

UNIT-IV (15)

Exports and Import Management, Concepts of international trade, Government assistance for export promotion, export house, export promotion counsel, patent and patent rights. Management Laws, Concepts of Contract Act, Offer and acceptance, Types of Contracts, Void contract, concept of Guarantee and Warranntee.

Suggested Readings

1. Management for Business and Industry, C.S.George Jr.
2. Principles of Management, Koontz and O 'Donnell.
3. Business Organization and Management, M.C.Shukla.
4. Organisation and Management, Sharma & Gupta, Kalyani publishers.
5. N. D. Kapoor Mercantile Law.
6. Production & Operation Management – P. Rama Murthy.

The syllabus for this paper to be taught keeping in mind the aspects of commercialization, marketing and management of Biotechnological products. Seminars, Case studies, are included as a supportive work to clear concepts of Management.

OR

NB - 441: Nanobiotechnology (60)
(Prerequisite: B. Sc. Life Science)

UNIT 1 (15)

Nanotechnology: Concept, definition and history. Nano and Nature: Nanoscopic colours (Butterfly wings), Bioluminescence (fireflies), Tribology (Gecko's Sticky Feet, Nasturtium Leaf-Lotus effect etc) in nature. The development of nanoscale science: size scale. Classification of nanomaterials:0D,1D,2D and 3D and types of nanomaterials (QDs, QW, CNT's, Bucky Balls, Nanocomposites etc). Quantum mechanics, Brownian motion, surface forces, surface to volume ratio.

UNIT 2 (15)

Visualization and manipulation tools Microscopy: Optical, electron (SEM, TEM), SPM (STM, AFM) Optical Tweezers. Inorganic nanoparticles: chemical, physical and biological methods of inorganic nanoparticle synthesis, Biological sysnthesis of nanoparicles using bacteria, fungi and plants. Silver nanoparticles, gold nanoparticles, cerium oxide nanoparticles, titanium oxide and zink oxide nanoparticles. Application of inorganic nanoparticles, Biological applications of inorganic nanoparticles.

UNIT 3 (15)

Introduction to biological nanoparticles and their applications: Exosomes, lipoproteins, ferritin, magnetite viruses . Biological nanomotors, protein assemblies: Kinesin and dynein, cilia. Bacterial flagella: structure and function; nanomotor. Ion channels: nanopores of high specificity. Bioinspired nanomaterials: DNA and peptide based. Interaction between biomolecules and nanoparticle surfaces.

UNIT 4 (15)

Nanomedicine: Applications of nanoscience in biology. Concept of disease, their causes, molecular and cellular progression of key diseases including infectious, inherited diseases, immunological diseases and cancer. Approaches to developing nanomedicines. Various kinds of nanosystems in use. Nanodrug delivery/administration, nano-devices for drug delivery and theranostics. Introduction to the potentials applications and challenges of nanomedicine. Nanomedicine and tissue engineering, nanobiomachines and nanorobots.

Suggested reading:

1.Nanotechnology :Technology Revolution of 21st Century by Rakesh Rathi, published by S. Chand.
2. Introduction to Nanoscience, by Stuart Lindsay.
3. Introduction to Nanomaterials and nanotechnology by Vladimir Pokropivny, Rynno Lohmus, Irina Hussainova, Alex Pokropivny and Sergey Vlassov
4. Nanomaterials by A.K. Bandyopadhyay; New Age International Publishers.
5. Nanotechnology by Mark Ratner and Daniel Ratner, Pearson Education.
6. Nano Essentials- T.Pradeep/TMH
7. Bharat Bhusan, "Springer Handbook of Nanotechnology", springer, Newyork, 2007

8. Hari Singh Nalwa, "Encyclopedia of Nanotechnology", USA 2011
9. James A. Schwarz, Cristian I. Contescu, Karol Putyera, "Dekker encyclopedia of nanoscience and nanotechnology" CRC Press, 2004.
10. Charles P. Poole Jr. and Franks. J. Qwens (2003) Introduction to Nanotechnology. John Wiley and Sons.
11. Ehud Gazit (2007) Plenty of Room for Biology at the Bottom: An Introduction to Bionanotechnology. Imperial college Press
12. Bharat Bhushan (2007) Springer Handbook of Nanotechnology. Springer Verlag.
13. Challa S., S. R. Kumar, J. H. Carola (2006) Nanofabrication towards biomedical application: Techniques, tools, Application and impact. John Wiley and sons.
14. Robert A. Freitas Jr (2003) Nanomedicine, Vol. I: Basic Capabilities.
15. Neelina H. Malsch (2005) Biomedical Nanotechnology. Taylor and Francis. CRC press.
16. Patrick Boisseau, Marcel Lahmani (2009) Nanoscience: Nanobiotechnology and Nanobiology. Springer Publishers.
17. Ralph S. Greco, Fritz B. Prinz, R. Lane Smith (Editors) (2004) Nanoscale Technology in Biological Systems. CRC Press
18. Harry F. Tibbals (2010) Medical Nanotechnology and Nanomedicine. CRC Press

LC BT 441: Laboratory Course VII **(60)**
(Prerequisite: B. Sc. Life Science)

1. Isolation of genomic DNA from plants.
2. Restriction digestion and analysis of DNA fragments by agarose gel electrophoresis.
3. Establishment of Molecular markers (RAPD/ISSR/RFLP).
4. Isolation of bacterial/fungal isolates and their preservation
5. Identification of bacterial/fungal isolates by 16S rDNA/18S rDNA amplification and sequencing.
6. Isolation of genomic DNA from environmental samples
7. Construction of 16S rDNA library, sequencing of clones and sequence analysis.
8. Preparation of competent cells (chemical or electro)
9. Isolation of plasmid DNA by miniprep/midiprep
10. Isolation of total RNA
11. Separation of RNA by denaturing gel electrophoresis
12. SDS page
13. Native Page
14. Identification and characterization of proteins resolved on 2D PAGE
15. Isolation of chloroplast
16. Tissue culture techniques: organ/anther/callus culture
17. Induction of somatic embryos
18. Protoplast isolation and cultures.
19. Genetic transformation for hairy root induction by *A. rhizogens*.

Suggested readings

1. Practical Biochemistry : An Introductory Course by Fiona Frais.
2. Methods in Enzymology Vol. I by S.P.Colowick and N.O.Kaplan eds.
3. Basic Biochemical Methods 2nd ed by R.R.Alexander and J.M.Griffith
4. Biochemical Methods 2nd ed. by S.Sadasivam and A. Manickam.
5. Hawk's Physiological Chemistry ed. by Bernard L Oser.
6. A Textbook of Practical Biochemistry by David Plummer.
7. Laboratory Manual in Biochemistry by S. Jayaraman.
8. Developing Bioinformatics computer skills – Cynthia Gibas and Per Jambeck
9. An introduction to Computational Biochemistry- C. Stan Tsai John Wiley and Sons, Inc. publications.

LC BT 442: Laboratory Course VIII (Project Work) (60)
(Prerequisite: B. Sc. Life Science)