

# NORTH MAHARASHTRA UNIVERSITY, JALGAON



Grade-B (2.88)  
(NAAC Re-accredited)

**SYLLABUS  
FOR**

**Master of Science**

In

**Biotechnology**

**PART- II**  
(Semester III and IV)

w.e.f. – 2016-17

**NORTH MAHARASHTRA UNIVERSITY, JALGAON**  
**M.Sc. (Part II) Biotechnology Semester III and IV**  
**Syllabus w.e.f. -2016-17**

**SEMESTER - III**

<b>BT-301:- RECOMBINANT DNA TECHNOLOGY</b>	<b>100 marks</b>
<b>BT-302:- PLANT BIOTECHNOLOGY</b>	<b>100 marks</b>
<b>BT-303:- ADVANCED ENVIRONMENTAL BIOTECHNOLOGY</b>	<b>100 marks</b>
<b>BT-304:- LAB COURSE –V</b>	<b>100 marks</b>
<b>BT-305:-LAB COURSE –VI</b>	<b>100 marks</b>

**SEMESTER - IV**

<b>BT-401:-FOOD AND PHARMACEUTICAL BIOTECHNOLOGY</b>	<b>100 MARKS</b>
<b>BT-402:- BIOINFORMATICS</b>	<b>100 MARKS</b>
<b>BT-403:-INDUSTRIAL AND BUSINESS BIOTECHNOLOGY</b>	<b>100 MARKS</b>
<b>BT-404:-LAB COURSE VII</b>	<b>100 MARKS</b>
<b>BT-405:-LAB COURSE–VIII (PROJECT)</b>	<b>100 MARKS</b>

**Note:**

- 1) The marks for each paper are distributed as external (60 marks) and internal (40 marks) examinations.
- 2) Practical courses to be conducted during the respective Semesters and, the external examination of practical courses will be conducted, at the end of respective semesters.
- 3) Each theory course to be completed in 50 lectures of 60 min duration each.

**UNIT – I**

Enzymes in genetic engineering: Restriction Endonucleases - classification, mode of action. Enzymes in modification - Polynucleotide phosphorylase, DNase, Methylases, phosphatases, polynucleotide Kinase, Ligases, S1 Nuclease, RNase and their mechanism of action. Vectors in recombinant DNA technology and its salient features, types of vectors – plasmids: pBR322, pUC18, pET21, cosmids, phages:  $\lambda$  and M13, SV40 Vector, Shuttle, Expression Vectors, Selectable Vectors, Artificial Vectors.

**UNIT – II:**

Methods of gene transfer: - Conjugation, Transformation, Transduction, Transposon, Electroporation, Microprojectile system, Liposome mediated transfer, gene gun, Calcium Phosphate method, DEAE dextran method. Molecular mechanism of anti sense technology.

**UNIT – III:**

Gene Cloning, Cells for cloning: *E.coli*, *S. cerevisiae*, Mammalian fertilized egg cells, Chinese hamster ovary cultured cells. Direct screening & direct selection, indirect screening techniques: HAT (Hybrid Arrested Translation), HST (Hybrid Selected/released Translation), Colony hybridization, Dot Blot hybridization, Immunological assay, Nucleic acid hybridization: DNA Probes, cDNA Probes, RNA Probes.

**Unit IV**

Expression strategies for heterologous genes, Expression in plant, Bacteria and yeast, site-directed mutagenesis, genes targeting and protein engineering. Generation of Novel plants foods and GMOs, Gene Bank, Animal pharming.

**Unit V**

Techniques and Application: DNA sequencing – Maxam-Gilbert method and Sanger's method, Oligonucleotide synthesis, DNA fingerprinting, Mapping of DNA, Gene Libraries: Genomic, cDNA. DNA foot Printing, Chromosome walking and Chromosome jumping, Transposon tagging, Hazards and impact of genetic engineering on society.

**Recommended Books:**

1. Principles of gene manipulation (2006) by Sandy Primrose, Richard Twyman, Bob Old, Giuseppe Bertola (Black Well Publication).
2. Molecular cloning: A laboratory manual (2000) by J. Sambrook, E.F. Fritsch and T. Maniatis (Cold Spring Harbor).
3. Gene cloning and DNA analysis: An introduction (2006) by TA Brown (Blackwell Sci. Ltd).
4. Molecular biotechnology (1994) by S.B. Primrose (Blackwell, Scientific Publishers. Oxford).
5. PCR Strategies, M.A. Innis, D.H. Gelfant & J.J. Sninsky, 1995. IRL Press.
6. Recombinant DNA (2nd Ed), J.D. Watson, M. Gillman, J. Witkowsky and M. Zoller, 1992. Scientific American books, N.Y.
7. Genetic Engineering of Animals, A. Puhler, 1993. VCH Publishes, Weinheim FRG.

**Unit - I**

Introduction to plant cell and tissue culture and historical perspective. Laboratory organization, aseptic manipulations and culture media–composition, preparation and development. Callus culture; Initiation and maintenance of suspension culture- batch and continuous culture, assessment of growth and viability; Static techniques of single cell culture. Micro propagation Organogenesis, somatic embryogenesis and synthetic seeds.

**Unit - II**

Meristem culture, shoot tip culture and production of virus free plants. Somaclonal variations, molecular basis of variation and their significance in plant breeding. In vitro production of haploid plants – Androgenesis (anther and pollen culture) and Gynogenesis (ovary and ovule culture). Significance and uses of haploids in agriculture. embryogenesis and embryo rescue technique.

**Unit - III**

Protoplast culture and somatic hybridization – Isolation, culture and fusion of protoplast, selection of fusion products and plant regeneration, assessment of somatic hybrid plants, production of cybrids, In vitro germplasm conservation and cryopreservation.

**Unit - IV**

Organization of plant genome – Nuclear genome, Chloroplast genome and mitochondrial genome. Transposon and T–DNA tagging. Chloroplast transformation – vector designing, method and advantages, Direct gene transfer in plants, selectable markers, reporter genes and promoters used in plant vectors, molecular characterization of transformants.

Agrobacterium mediated transformation–Ti and Ri plasmids, role of virulence genes, mechanism of T-DNA transfer, vectors based on Ti and Ri plasmids–cointegrate and binary vectors. Gene silencing in transgenic plants.

**Unit - V**

Application of DNA technology - transgenic plants with reference to virus and pest resistances - herbicidal resistance - stress tolerance (heat & salt) - cytoplasmic male sterility - resistance to fungi and bacteria - delay of fruit ripening - Ecological risk assessment of genetically modified crops. Plant cells as biofactories for the production of secondary metabolites: bioreactors and immobilized plant cell culture, RFLP maps, linkage analysis, RAPD markers, STS, microsatellites, SCAR (Sequence Characterized Amplified Regions), SSCP, AFLP, QTL.

## Recommended Books:

1. Plant tissue culture – Theory and Practice (2005) by Bhojwani S. S. and Razdan M. K., Elsevier publication.
2. Elements of Biotechnology by P. K. Gupta, Rastogi pub.
3. Biotechnology in crop improvement (1998) by H. S. Chawla, International Book distributing company.
4. Plant cell, organ and tissue culture (1995) by Gamborg O.L. and Phillips G.C., Springer Verlag pub. Germany.
5. Plant Tissue Culture – Basic & Applied (2005) by Jha T.B. & Ghosh B., Universities press.
6. Plant cell culture – A practical approach (1994) Dixon R.A., Gonzales R.A. Oxford University press, UK.
7. Plant Tissue Culture Smith R.H. (2000), Plant Tissue Culture, Academic Press
8. Evans D.A. (2003), Plant Cell Culture, Taylor & Francis.
9. Plant Genetic Engineering Vol. 1 - 6 (2003) Singh R. P and Jaiwal P. K.(Eds.), Sci tech publishing LLC, USA.
10. Gene transfer to plants by Potrykus I. and Spangenberg G., Springer Verlag, Germany.
11. Plant biotechnology (2000) by Hammond J, McGarvey P. and Yusibov V.(Eds.) Springer verlag, Germany.
12. Plant gene isolation – Principles and practice (1996) by Foster G.D. and Twell D., John Wiley & Sons, USA.
13. Plant Biotechnology – The genetic manipulation of plants (2003) by Slater A., Scott N. and Fowler M., Oxford pub.
14. Practical application of Plant Molecular Biology (1997) by Henry R.J., Chapman and Hall.
15. Plants, genes and agriculture (1994) by Chrispeels M.J., Sadava D.E, Jones & Bartlett pub., UK.
16. Plant Genetic Engineering; Singh RP and Jaiwal PK (eds), Sci tech Publishing LLC.
17. Plant Gene Isolation – Principles and Practice; Foster GD and Twell D, John Wiley & Sons.
18. Gupta P.K. (2004) *Biotechnology and Genomics*. Rastogi Publications, Meerut, India.
19. Owen M.R.L. and Pen J. (Eds) (1996) *Transgenic Plants: A Production System for Industrial and Pharmaceutical Proteins*. John Wiley & Sons, England.

## BT-303 ADVANCED ENVIRONMENTAL BIOTECHNOLOGY 100 marks

### Unit-I:

*Solid waste management:* Types and sources of solid waste, Management by composting and vermiculture, Materials and Physiochemical characteristics of compost.

*Waste water management:* Activated sludge process, Nitrification, Denitrification sludge and anaerobic digestion (UASB), Oxidation ditch and Carousal systems.

*Air pollution management:* Biotechnological approach for air pollution management. Strategy for removal/destruction of SO<sub>x</sub> and NO<sub>x</sub>

### Unit-II:

*Bioremediation:* Characterization of site for bioremediation, Engineered *In Situ* and Intrinsic *In Situ* bioremediation, *Ex situ* bioremediation, Evaluation of bioremediation, Bioremediation of soil contaminated with oil spills.

*Biodegradation:* Assimilation, Detoxification, Activation, Bio-availability, Recalcitrance, Cometabolism and Biotransformation. Factors affecting biodegradation, Predicting products of biodegradation, Biodegradation of environmental contaminants (Pesticides, Lignin, Halogenated hydrocarbons)

### Unit-III:

*Biodiversity (Global and National):* Biodiversity hot spots, Biodiversity characteristics of India, Conventions on biological diversity, Causes of biodiversity losses, Extinct and endangered species, Conservation methods, National parks, Sanctuaries, Sacred groves, Gene banks.

*Measurement of biodiversity:* Types of Biodiversity ( $\alpha$ ,  $\beta$  and  $\gamma$ ), Diversity indices (Simpson's, Shannon index, Sorensen's similarity index)

### Unit-IV:

*Biosensors:* Types of biosensor, Working mechanism and examples of biosensors based on DNA, antibodies, enzymes, microorganisms. Applications of biosensors in the monitoring of heavy metals, BOD, nitrogen compounds, polychlorinated biphenyls, phenolics and organophosphorus compounds.

*Biofuels:* Advantages of biofuels, Energy from biomass, Biogas, Biohydrogen and Biodiesel.

*Biosafety:* Biosafety guidelines and regulations with special reference to India, Biosafety and environmental concerns of transgenic plants, animals and nanotechnology.

### Unit-V:

*Toxicity:* Definitions and significance of various concepts e.g. Persistence, Bioaccumulation, Biomagnification, Risk, Toxicity (acute and chronic), Threshold dose. Factors affecting toxicity of a chemical agent. Tests for evaluation of genotoxicity, mutagenicity, and carcinogenicity (Ames test, Micronucleus test and Comet assay).

*Antidotal procedures:* Antidote therapy, Mode of antidote action, Specific antidotes against iron, cyanide, arsenic, lead, methanol and acetylcholinesterase inhibitors.

**Recommended Books:**

1. Agarwal S.K. (2005) *Advanced Environmental Biotechnology*. APH Pub Co, New Delhi.
2. Alexander M. (1999) *Biodegradation and Bioremediation*. 2nd Edition, Academic Press, USA.
3. Asthana D.K. and Asthana M. (2001) *Environment: Problems and Solutions*. S. Chand & Co. Ltd., New Delhi.
4. Chatterji A.K. (2002) *Introduction to Environmental Biotechnology*. Prentice Hall of India Pvt Ltd., New Delhi.
5. Evans G.M. and Furlong J.C. (2003) *Environmental Biotechnology: Theory and applications*. John Wiley & Sons, England.
6. Huges W.W. (1996) *Essentials of Environmental Toxicology*. Taylor and Francis.
7. Krishnamurthy K.V. (2003) *Textbook of Biodiversity*. Science Publishers Inc, USA.
8. Mohapatra P.K. (2006) *Textbook of Environmental Biotechnology*. IK International, New Delhi.
9. Rana SVS (2009) *Environmental Biotechnology*. Rastogi Publications, Meerut.
10. Rittmann B.E. and McCarty P.L. (2001) *Environmental Biotechnology: Principles and Applications*. McGraw-Hill, USA.
11. Shaw I.C. and Chadwick J. (1998) *Principles of Environmental Toxicology*. Taylor & Francis Ltd., UK.
12. Thakur I. S. (2006) *Environmental Biotechnology: Basic Concepts and Applications*. IK International Pvt Ltd., New Delhi.
13. Yadav P.R. and Tyagi R. (2006) *Environmental Biotechnology*. Discovery Pub House, New Delhi.

1. Preparation and sterilization of MS medium, stocks and explants
2. Callus induction, Regeneration of shoots, Root induction
3. Meristem culture /Anther culture/ pollen culture/ using various explants
4. Protoplast isolation, fusion and culture
5. Somatic embryogenesis
6. Development of synthetic (Artificial) seeds/ Production of secondary metabolites
7. Micropropagation of banana, citrus Papaya, Sugarcane etc.
8. Isolation of pBR-322 from E.coli
9. Preparation of competent cells
10. Transformation by calcium chloride method
11. Screening of bacterial colonies using X-gal and IPTG
12. Southern blot/ Northern blot / Western blot/ PCR (D)
13. Isolation and purification of yeast DNA

**Recommended Books:**

1. Aneja K.R. *Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Cultivation*. 2nd Edition, Wishwa Prakashan, New Age International Pvt Ltd., New Delhi.
2. Reinert J. and Yeoman M.M. (1989) *Plant Cell and Tissue Culture: A Laboratory Manual*.
3. Smith R.H. (1992) *Plant Tissue Culture: Techniques and Experiments*.
4. Henry R.J., Chapman and Hall Practical application of Plant Molecular Biology (1997)
5. Gene Transfer and expression protocols - methods in molecular biology volume 7, E.T. Murray, 1991. Humana Press
6. Genetic engineering by Sandhya Mitra ,Macmillan Publication
7. DNA Cloning: A practical approach (1995) by D.M. Glover and B.D. Hames (IRL Press, Oxford).



## BT-305 LAB COURSE –VI 100 marks

1. Determination of acidity, alkalinity, salinity of water/soil.
2. Determination of COD of sewage/industrial waste water.
3. Estimation of total nitrogen of soil (Kjeldal's method)
4. Vermicomposting of different waste substrates in laboratory reactors
5. Co-composting of biosolids and municipal solid waste (MSW) / kitchen waste / paper waste.
6. Determination of adsorption isotherm (adsorption of acetic acid on charcoal)
7. Determination of soil microbial activity by CO<sub>2</sub> evolution method
8. Determination of MIC of pesticide / heavy metal against bacterial culture
9. Production of biodiesel from microalgae
10. Testing of cytotoxicity (onion root tip assay/pollen germination) of water polluted with pesticides
11. Comet assay to assess the DNA damage due to pesticide exposure
12. Hydroponic plant assay to test phytoaccumulation of heavy metals/xenobiotics
13. Estimation of metal content in soil, compost, vegetables, drinking water and waste waters using atomic absorption spectroscopy
14. Estimation of bioavailable / extractable concentration of zinc and cadmium in sediment sample using AAS
15. Estimation of Biodiversity Index of particular habitat

**Unit-I**

Biotechnology in food, biofortification, Nutraceuticals, Prebiotics, Probiotics, Low cost nutrient supplements, Space foods. Food Processing: Introduction, Causes of food spoilage, Objectives of food processing, Effect of Processing (Heat, Acid and Alkali) on food constituents. Food Preservation and food additives: Methods of food preservation (low temperature, high temperature, osmotic pressure, dehydration), Food irradiation, Food additives (Preservatives, colour, emulsifiers and stabilizers)

**Unit-II**

Technology of typical food / food products: Dairy products, bread, fruit beverages, flesh foods. Food Adulteration: Types of adulterants (intentional and incidental). Food Laws and standards. Packaging and Labeling of foods: Elementary idea of designing, Canning and Packing, Laws related to packaging, New trends in packaging. New trends in foods: Introduction, Soya foods, Food fads, Organic foods, Edible films.

**Unit-III**

Genetic engineering of baker's yeast, Biotechnology of wine yeast, Biotechnology of  $\beta$ -carotene from *Dunaliella*, SCP: *Spirulina* and *Chlorella*. Application of bacterial cellulase for clarification of fruit juices Application of ELISA assays for detection and quantitation of toxins in foods and *E.coli* in food, Biosensors for food quality assessment, Safety of fermented foods.

**Unit-IV**

Estimation of toxicity: Concept of LD50 and ED50 and their significance, Preclinical trials: Pharmacokinetics and Pharmacodynamics of Peptide and Protein drugs, Clinical trial design: Trial size and study population, Randomized control studies. Guides to good manufacturing practice, FDA, CDS, Water for processing, Final product fill, Freeze drying, labeling and packaging, Analysis of final product: Protein and DNA based contaminants, Endotoxin detection, Pyrogen detection, Microbial and viral contaminants, Validation studies.

**Unit-V**

Biopharmaceuticals of animal, plant and microbial origin, Hematopoietic growth factors and coagulation factors, Interferons and cytokines for antiinfective and cancer therapy, Insulin and growth hormones, Genetically improved vaccines, Recombinant thrombolytic agents: Tissue type plasminogen activator, Gene therapy, *Ex-vivo* and *In vivo* gene therapy, Antigene and antisense therapy.

## Recommended Books:

1. Industrial Microbiology, 1983, 4th Edition, Prescott and Dunn's, Gerald Reed, AVI Publishing Company Inc. Connecticut.
2. Food Biotechnology. (Ed) (1982, 1987). by Knorr, D. Marcel Dekker, New York
3. Bielecki S. Tramper J. and Polak J. (2000) *Food Biotechnology*. Elsevier.
4. Wood R., Nilsson A. and Wallin H. (1998) *Quality in the Food Analysis Laboratory*. Royal Society of Chemistry.
5. Earry R. (Ed) (1998) *The Technology of Dairy Products*. 2nd Edn, Blackie Academic & Professional, UK.
6. Food Biotechnology by Kalidas Shetty, Taylor & Francis
7. Singh R. (2004) *Food Biotechnology*. Vol.1 & 2, Global Vision Publishing House, Delhi.
8. Belits H.-D. and Grosch W. (1999) *Food Chemistry*. 2nd Edition, Springer Verlag, Germany.
9. Jay J.M. (1992) *Modern Food Microbiology*. 4th Edition, Chapman & Hall, New York, NY, USA.
10. Satyanarayana U. (2005) *Biotechnology*. Uppala Author Publisher Interlinks,Vijaywada, India.
11. Spencer J.F.T. and de Spencer A.L.R. (2001) *Food Microbiology Protocols*. Humana Press,
12. Garry W. (2004) *Biopharmaceuticals: Biochemistry and Biotechnology*. 2nd Edition, John Wiley & Sons, England.
13. Rodney J.Y.Ho and Gibaldi M. (2003) *Biotechnology and Biopharmaceuticals: Transforming Proteins and Genes into Drugs*. Wiley- Liss, A John Wiley & Sons, Inc., New Jersey.
14. Zito S.W. (Ed) (1997) *Pharmaceutical Biotechnology: A Programmed Text*. 2nd Edition, Technomic Publishing Co., Inc., USA.
15. Propst C. L. and Perun T.J. (Eds) (1992) *Nucleic Acid Targeted Drug Design*. Blackwell Synergy.
- 16.** Reece R.J. (2004) *Analysis of Genes and Genomes*. John Wiley & Sons,Ltd., England.

**UNIT-I**

**Genomics:** The impact of bioinformatics and functional genomics on biology in the 'Post genomic era'. Approaches for finding genes and regulatory regions in genomic sequence, structural genomics, Functional genomics, Comparative genomics, oligonucleotide fingerprinting, Gene chips.

**UNIT-II**

**Proteomics :** Novel approaches to protein expression analysis: 1D and 2 D Electrophoresis, Immobilized pH gradient, Sample preparation, First dimension criteria, second dimension criteria, Stabilization, Electro blot, Image analysis, Digital imaging, Spot detection and quantification, Gel matching.

Database for 2D gel. Mass Spectrometry for protein and peptide analysis: MALDI-TOF, Application of proteome analysis to drug development. Protein chips.

**UNIT-III**

Introduction to biological databases – NCBI, PUBMED, sequence databases: Gene bank, DDBJ, Swissprot, PIR, EMBL, structural databases: PDB, MMDB, specialized databases, sequence retrieval system - SRS, ENTREZ, Expasy.

**UNIT-IV**

Sequence analysis and phylogeny - sequence and similarity: FASTA, BLAST, sequence alignment: local, global, pair wise and multiple sequence, introduction to scoring matrices-PAM and BLOSSUM, introduction to phylogenetic trees, Protein structure prediction - Secondary structure prediction, 3D Structure prediction.

**UNIT-V**

Data Mining and Data Visualization, Software for Data Visualization ,CN3D,Rasmol,Mol –Mol, Pymol, Chimera, SWISS PDB Viewer, DISCOVERY STUDIO, and MODELLER, Introduction to Bioperl and Biojava, Online Free web resources.

## Recommended Books:

1. Bioinformatics: Sequence and Genome Analysis by David W. Mount, Cold Spring Harbor Laboratory Press
2. Biological Sequence Analysis : Probabilistic Models of Proteins and Nucleic Acids by Richard Durbin, Sean R. Eddy, Anders Krogh, Graeme Mitchison, Cambridge University Press.
3. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, Second Edition by Andreas D. Baxevanis, B. F. Francis Ouellette, Wiley-Interscience
4. Foundations to bioinformatics – Evolution, similar macromolecular components, constancy of gene number and core proteome in closely related organisms
5. Bioinformatics data – nucleic acid sequence, protein sequence, protein structure, genomic, proteomic and metabolomic information
6. Bioinformatics databases – types, design, file formats, access tools with examples
7. Bioinformatics tools and Resources – free online tools, downloadable free tools, software packages, internet, Bioinformatics books and Journals, Bioinformatics web-portals
8. Daniel C. Leibler, (2002), Introduction to Proteomics: Tools for New Biology, Humana Press, Totowa, NJ. Branden, Carl and Tooze John. 1999. Introduction to Protein Structure (2nd. Ed.),Garland Publishing, NY, USA.
9. Mount, David, W., (2001); Bioinformatics: Sequence and Genome Analysis, Cold Spring Harbor Lab. NY,
10. Pennington, S, (Editor), M. J. Dunn (Editor); (2001); Proteomics: From Proteins Sequence to Function, Springer Publications
11. Palzkill, Timothy; (2002); Proteomics, Kluwer Academic Publishers
12. Suhai, Sandor, (ed). (2000); Genomics and Proteomics : Functional and Computational Aspects,Plenum Pub. Corp.
13. Shanmughavel, P. 2005. Principles of Bioinformatics, Pointer Publishers, Jaipur, India.

**Unit-I:**

Microbial Production of Organic Acids and Solvents: Production of alcohol by fermentation, Production, recovery and applications of Glycerol, Acetone and butanol, Citric acid, Gluconic acid, Acetic acid, Lactic acid,

**Unit-II**

Microbial Production, recovery and applications of Amino Acids: L-Glutamic acid, L-Lysine, L-Phenylalanine and L-Tryptophan, L-Threonine. Microbial Production, recovery and applications of Vitamins: Vitamin-B12 and Riboflavin. Production of Chemotherapeutic Agents: Production, recovery and applications of antibiotics: Penicillin, Streptomycin, Tetracycline, Erythromycin.

**Unit-III:**

General features of microbial polysaccharides, Production, recovery and applications of polysaccharides: Xanthan, Dextran and Alginate, Polyhydroxy alkanates: Chemistry and properties, Polyhydroxybutyrate (PHB), Biopol-a biodegradable plastic, Microbial recovery of petroleum

**Unit-IV:**

Production and applications of Proteases, Pectinases, Cellulases, Lipase, Glucose isomerase, Penicillin acylase, Microbial transformation, Types of bioconversion reactions: Oxidation, Reduction, Hydrolytic reactions, Condensations, Transformation of steroids and sterols. Transformation of nonsteroidal compounds: L-ascorbic acid, Prostaglandins, Antibiotics,

**Unit-V:**

Principles of management, Marketing concepts and functions, Time event-time study (CPM and PERT), Concept and Importance of entrepreneurship and self-employment in India, ISO 9000 quality system standards, Biosafety & IPR

**Recommended Books:**

1. Manual of Industrial Microbiology and Biotechnology, III edition (1999), Arnold L. Demain and Julian Davies, ASM press, Washington DC
2. Food microbiology, Frazier
3. Industrial Microbiology, Casida
4. Principles of Fermentation Technology by Whitaker, Stanbury, Hall

1. Analysis of milk and milk products – Lactose/ Protein/ Phosphorus and Calcium content of milk powder.
2. Determination of adulterants of food: NaHCO<sub>3</sub>, Glucose, Starch, Borax Argemone oil in oil / Mineral oil in vegetable oil / Dalda in ghee.
3. Chemical estimation of thiamine, riboflavin in food stuffs.
4. Isolation and biochemical testing of probiotic cultures (Lactobacilli) from food samples (curd, intestine, sauerkraut, dosa, etc)
5. Aflatoxin testing in ground nut / maize
6. Bioassay of vitamin /antibiotics
7. Production and isolation of bacterial exo-polysaccharides
8. Production and estimation of alkaline protease from bacterial source
9. Production and estimation of bacterial lipase
10. Production of sauerkraut by microorganisms
11. Pair wise alignment of DNA and Protein
12. To perform multiple sequence alignment of DNA and Protein
13. Protein structure visualization and molecular modeling
14. Secondary structure prediction
15. To perform phylogenetic analysis

**Project (Dissertation)**

The project allotted during the fourth semester will be continued and it is expected that the students will design experiments and collect experimental data to deduce conclusions. At the end, they will submit a detailed thesis for evaluation. The students should be introduced to research methodology in the beginning through few lectures.

The approach towards the execution of project should be as follows:

- 1. Selection of topic relevant to priority areas of biotechnology.**
- 2. Collection of literature from libraries, internet, on-line journals, etc.**
- 3. Planning of research experiments**
- 4. Performing the experiments with scientific and statistical acceptability.**
- 5. Presentation of observations and results.**
- 6. Interpretation of results and drawing important conclusions.**
- 7. Discussion of obtained results with respect to literature reports.**
- 8. Preparation of report (thesis) containing introduction, materials and methods, results and discussion, conclusions, bibliography.**
- 9. Presentation of research data.**