

**Kavayitri Bahinabai Chaudhari
North Maharashtra University
Jalgaon**

Syllabus

M.Sc. II (Semester III and IV)

BIOTECHNOLOGY

(Affiliated colleges)

[2019-2020]

Preface

Biotechnology has emerged as a multi-disciplinary subject that comprises many specialized areas including, Microbiology, Biochemistry, Physics, Engineering, Technology etc. The subject has impacted in almost every segment of human life. The skilled man power in Biotechnology compels the adoption of thorough knowledge of theoretical concepts and hands on experimental work of all fields of biotechnology. The study program in Biotechnology as one of the core subjects is designed to cultivate a scientific attitude and an interest towards the modern areas of biotechnology in particular and life science in general along with the collection and interpretation and presentation of scientific data in proper manner. It will help the students to become critical and curious in their outlook. The content of syllabus has been prepared to accommodate the fundamental aspects as well as advanced developments in various disciplines of Biotechnology and to complement the needs of various applied sectors of Biotechnology. Besides, the students will be equipped with knowledge in the newer areas of microbial physiology, diversity, biomolecules, basic and diagnostic Immunology, molecular biology, analytical tools and biostatistics, bioprocess technology, Biochemistry, Enzymology, and its application in Medicine, Agriculture, Industry, Proteomics, Genomics, Metabolomics, Bioinformatics, Nano-biotechnology etc. The syllabus is simplified to accommodate the present and future needs of Biotechnology in various fields such as, Agriculture, Industrial, Environmental, Pharmaceutical, Clinical and Diagnostic, Research and Development etc. Hence, more emphasis on Theory and Practical course in new restructured course is bestowed to impart skill-set essentials to further Biotechnology and build interdisciplinary approach.

Learning Objectives

- To impart fundamental and applied aspects of Recombinant DNA technology.
- To understand the mechanisms and process of gene transfer.
- To understand the principles and methods of gene cloning and recombinant selection.
- To understand the principles of gene sequencing and other methods of rDNA technology.
- To study the basics of gene expression.
- To gain knowledge and gain awareness about different types of environmental pollutions, causes, impact, prevention, control measured, and other issues related to the pollution.
- To understand the bioremediation and biodegradation
- To understand the methods of environmental monitoring

Learning outcome

- Learn basics in recombinant DNA Technology.
- Learn basics about r-DNA technology from gene insertion to expression strategies of recombinant genes in various hosts.
- Productively translate both basic and frontier research concepts regarding Recombinant DNA technology.
- Gain an understanding of the causes, types and control methods for environmental pollution
- Learn basics about objective view of the application of biotechnological knowhow in tackling environmental problem
- Understanding of bioremediation and biodegradation of various pollutants/hazardous compounds
- Learn basics about objective view of the application of biotechnological know.

Duration: The duration of M.Sc. (Biotechnology) degree program shall be TWO years.

Medium of instruction: The medium of instruction for the course shall be English.

Course structure:

SEMESTER-III (Theory Courses)				
Course	Title	Hours/ week	Marks	Hours
BT-301	Recombinant DNA Technology	04	100	03
BT-303	Plant Biotechnology	04	100	03
BT-303	Advanced Environmental Biotechnology	04	100	03
BT-304	Methods in Plant Biotechnology	04+04	100	06
BT-305	Methods in Environmental Biotechnology	04+04	100	06
SEMESTER -IV (Theory courses)				
BT-401	Food and Pharmaceutical Biotechnology	04	100	03
BT-402	Bioinformatics	04	100	03
BT-403	Industrial and Business Biotechnology	04	100	03
BT-404	Methods in Biotechnology	04+04	100	06
BT-405	Biotechnology Practical (Project Dissertation work)	04+04	100	06

- Each theory and practical course are to be completed in 50 lectures each of 60 min duration,
- Each theory and practical course will be of 100 marks comprising of 40 marks internal (20 marks of 2 internal examinations) and 60 marks external examination.
- **Theory examination** will be of 60 Marks for three hours duration for each theory course. There shall be 5 questions each carrying equal marks (12 M each).
- **Question paper pattern**
 - Question 1 (12 marks): 6 sub-questions, each of 3 marks; answerable in brief and based on entire syllabus, attempt any 4 out of 6 questions.
 - Question 2, 3 and 4 (12 M each): based from Unit I, II, III, IV and V, respectively, each question has 3 sub-questions of 6 marks each and answer only 2 sub-questions from each Q2, Q3, and Q4.
 - Question 5 (12 M): answer only 3 out of 5 each 4 marks in brief, based on all 5 units,
- **Practical Examination:** Practical examination shall be conducted by the respective college at the end of the semester. Practical examination will be of minimum 3 hours (or 6 hours based on incubation condition requirements) duration and shall be conducted as per schedule (10 am to 1 pm or 10 to 5 pm).
 - There shall be 5 marks for laboratory log book and well written journal and 10 marks for viva-voce,
 - It is mandatory for students to bring the certified journal during practical examination.
 - There shall be one expert and two examiners (external and internal) per batch for the practical examination
- **Internal examination** (40 Marks each semester): Internal assessment of the student by respective teacher will be comprehensive and continuous, based on written test for theory and experiments for practical courses.
- **Equivalence for M.Sc. (Biotechnology)** is given below:

Old Syllabus (2016- 17) Semester III (Pattern 60:40)	New Syllabus (2019-20) Semester III (Pattern 60:40)
BT- 301: Recombinant DNA Technology	BT- 301: Recombinant DNA Technology
BT- 302: Plant Biotechnology	BT- 302: Plant Biotechnology
BT- 303: Advanced Environmental Biotechnology	BT- 303: Advanced Environmental Biotechnology
BT- 304: Laboratory Course – V	BT- 304: Methods in Plant Biotechnology
BT- 305: Laboratory Course – VI	BT- 305: Methods in Environmental Biotechnology
Semester IV (Pattern 60:40)	Semester IV (Pattern 60:40)
BT- 401: Food and Pharmaceutical Biotechnology	BT- 401: Food and Pharmaceutical Biotechnology
BT- 402: Bioinformatics	BT- 402: Bioinformatics
BT- 403: Industrial and Business Biotechnology	BT- 403: Industrial and Business Biotechnology
BT- 404: Laboratory Course – VII	BT- 404: Methods in Biotechnology
BT- 405: Laboratory Course – VIII	BT- 405: Biotechnology Practical (Project Dissertation Work

BT-301 - Recombinant DNA Technology		
UNIT	Topics	Lectures
I	<p>Introduction to Recombinant DNA Technology</p> <ul style="list-style-type: none"> ▪ Historical perspective of r-DNA technology. ▪ Endonucleases and exonucleases - Classification and mode of action. ▪ Enzymes in modification – Polynucleotide phosphorylase, DNases, Methylases, phosphatases, polynucleotide kinase, ligases, S1 Nuclease, RNase and their mechanism of action and applications. ▪ Vectors in r-DNA technology and their salient features, types of vectors- plasmids; pBR322, pUC18 cosmids, phages; and M13, SV40 vector, Shuttle, Expression vectors, Selectable vectors, Artificial vectors - BAC, YAC and PAC ▪ Genomic library and cDNA library. 	12
II	<p>Gene Transfer</p> <ul style="list-style-type: none"> ▪ Biological methods – Conjugation, transformation, transduction and transfection. ▪ Physical methods - Electroporation, microprojectile system, gene gun and bolistics. ▪ Chemical methods- Liposome mediated transfer, calcium phosphate method and DEAE-dextran. ▪ Molecular methods - molecular mechanism of antisense technology, Advanced Tools in genetic engineering: CRISPR, Genome re-coding, lentivirus and Cre/ loxP system. 	10
III	<p>Gene cloning and recombinant selection</p> <ul style="list-style-type: none"> ▪ Gene cloning, Cells for cloning; <i>E. coli</i>, <i>S. cerevisiae</i>, mammalian fertilized egg cells and Chinese hamster ovary cultured cells. ▪ Direct screening and 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. 	10
IV	<p>Analytical Techniques in r-DNA technology</p> <ul style="list-style-type: none"> ▪ Sequencing methods- Maxam Gibert method, Sanger’s method, automated DNA sequencing, NGS methods- pyrosequencing and ABi-solid method. ▪ Genetic mapping- basic of genetic mapping, Linkage analysis, DNA markers for genetic mapping- RFLP, SSLP, SNP. ▪ Physical mapping- Restriction maps, Radiant hybrid maps and STS maps. 	10
V	<p>Expression strategies and applications of r-DNA technology</p> <ul style="list-style-type: none"> ▪ Expression strategies for heterologous genes- Expression in plants, Bacteria and Yeast. ▪ Application of r-DNA technology - DNA fingerprinting. Genetic disease- Detection and Diagnosis Gene therapy- gene delivery systems, viral and non- viral. Bio-pharming and recombinant vaccines. ▪ CRISPR technology 	08
Suggested Readings:		
1. Dale, J. and Schantz, M. (2008) From Genes to Genomes, 2nd edition, John Wiley and Son Ltd.		

2. Brown, T. A. (2010) Gene Cloning and DNA Analysis: An introduction, 6th edition, Wiley-Blackwell Publisher, UK.
3. Winnacker, E. (2003) From Gene to Clones; Introduction to gene technology, 4th edition, Panima Publisher, India.
4. Gerstein, A. (2004) Molecular Biology Problem solver: A Laboratory Guide, A John Wiley and Sons, Inc., Publication, USA.
5. Watson, James D., Baker, Tania A., Bell, Stephen P., Gann, Alexander, Levine, Michael, Losick, Richard, CSHLP Inglis (2008) Molecular Biology of the Gene, 6th Edition, Cold Spring Harbor Laboratory.
6. Glick, B. R., Pasternak, J. J. and Patten C. L. (2010) Molecular Biotechnology, 4th edition, ASM Press, USA.

BT-302 - Plant Biotechnology		
UNIT	Topics	Lectures
I	<p>Introduction to Plant Biotechnology</p> <ul style="list-style-type: none"> ▪ Introduction to plant cell and tissue culture and historical perspective. ▪ Laboratory organization, Aseptic manipulations and Culture media composition and Preparation, ▪ Initiation and maintenance of suspension culture (batch and continuous culture), ▪ Assessment of growth and viability - Static techniques of single cell culture. Micropropagation (merits and demerits), Organogenesis, Somatic embryogenesis and synthetic seeds. 	10
II	<p>Plant Tissue culture techniques I</p> <ul style="list-style-type: none"> ▪ Callus culture, Meristem culture, Shoot tip culture, Embryo, seed and organ culture ▪ Bioreactors and immobilized plant cell culture. In vitro production of haploid plants – Androgenesis (anther and pollen culture), Microspore culture and Gynogenesis (ovary and ovule culture), factors affecting gynogenesis ▪ Significance and uses of haploids. Embryogenesis and Embryo rescue technique; Chromosome elimination techniques. 	10
III	<p>Plant Tissue culture techniques II</p> <ul style="list-style-type: none"> ▪ Protoplast culture and Somatic hybridization – Isolation, culture and fusion of protoplast, ▪ Selection of fusion products and Plant regeneration, Assessment of somatic hybrid cells, Production of cybrids, ▪ In vitro germplasm conservation and cryopreservation. Somaclonal variations, Molecular basis of variation and their significance in plant breeding 	10
IV	<ul style="list-style-type: none"> ▪ Methods of gene transfer in plants ▪ 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, 	10

	<ul style="list-style-type: none"> ▪ Role of virulence genes, Mechanism of T-DNA transfer, Vectors based on Ti and Ri plasmids-Cointegrate and Binary vectors. Gene silencing, PTG'S, RNAi, Antisense technology. 	
V	<p>Transgenic Plants</p> <ul style="list-style-type: none"> ▪ Transgenic plants for resistance to virus, pest, fungi, bacteria herbicide ▪ Stress tolerance (temperature and salt), Cytoplasmic male sterility for hybrid seed production, Delay of fruit ripening. ▪ Ecological risk assessment of genetically modified crops ▪ Plant cells as bio factories for the production of secondary metabolites - Biopolymer production, proteins, lipids, planti bodies, vaccines, therapeutic proteins. ▪ CRISPR technology, CAS-9, Terminator seed technology, Bioethics and plant biotechnology. 	10

Suggested Readings:

1. Bhojwani S. S. and Razdan M. K. (2005) Plant tissue culture – Theory and Practice Vol 5, Elsevier Science, 9780080539096
2. Gupta P.K. (2016), Elements of Biotechnology, Rastogi, Publications, Meerut (UP), India. ISBN 978-81-7133-937-2
3. Chawla, H.S. (1998) Biotechnology in Crop Improvement, International Book Dist. Co.
4. Gamborg O.L. and Phillips G. C (1995) Plant Cell, Organ and Tissue Culture, Springer Verlag, Germany.
5. Jha T.B. and Ghosh B (2005) Plant Tissue Culture–Basic and Applied, Orient Blackswan; First Edition, ISBN-10: 8173714886
6. Dixon R.A., Gonzales R.A. (1994) Plant Cell Culture – A Practical Approach, Oxford University Press, UK.
7. Smith R H (2000) Plant Tissue Culture, Academic Press, NY
8. Coleman, Julian, Evans, David and Kearns Anne (2003) Plant Cell Culture, Taylor and Francis, ISBN 9781859963203.
9. Slater A., Scott N. and Fowler M (2003) Plant Biotechnology – The Genetic Manipulation of Plants, Oxford Publication.
10. Henry R.J (1997) Practical Application of Plant Molecular Biology, Chapman and Hall.
11. Chrispeels M. J. and Sadava D.E (1994) Plants, Genes and Agriculture Jones & Bartlett Publication,
12. Singh RP and Jaiswal PK (2001), Plant Genetic Engineering, Sci Tech Publishing LLC.
13. Foster G.D. and Twell D Plant Gene Isolation – Principles and Practice by., John Wiley and Sons. ISBN: 9780471955399
14. Owen M.R.L. and Pen J (1996), Transgenic Plants: A Production System for Industrial and Pharmaceutical Proteins, John Wiley and Sons, England.
15. Das H K (2009) Textbook of Biotechnology, 4th edition, Wiley India Pvt. Ltd. New Delhi

BT-303: Advanced Environmental Biotechnology		
UNIT	Topics	Lectures
I	<p>Pollution</p> <ul style="list-style-type: none"> ▪ Air pollution - Ambient air quality: monitoring and standards (National Ambient Air Quality Standards of India); air quality index; sources and types of pollutants (primary and secondary); smog (case study); effects of different pollutants on human health (NOx, SOx, PM, CO, CO₂, hydrocarbons and VOCs) and control measures; indoor air pollution: sources, effects on human health and remedial strategies. Vehicular pollution and control measures. 	12

	<ul style="list-style-type: none"> ▪ Soil pollution - Causes of soil pollution and degradation; effect of soil pollution on environment, vegetation and other life forms; control strategies. Global and Indian perspective, major pollutants and Biotechnological approach for soil pollution management like on soil hardening, contaminant detection, soil leached pesticides denaturation or conversion. ▪ Water pollution - Sources of surface and ground water pollution; water quality parameters and standards; organic waste and water pollution; eutrophication; effect of water contaminants on human health (nitrate, fluoride, arsenic, chlorine, cadmium, mercury, pesticides); water borne diseases; concept and working of effluent treatment plants (ETPs). 	
II	<p>Bioremediation and biodegradation</p> <ul style="list-style-type: none"> ▪ Bioremediation: Characterization of site for bioremediation, factors, engineered <i>in situ</i> and Intrinsic <i>in situ</i> bioremediation, <i>Ex situ</i> bioremediation, Evaluation of bioremediation, Bioremediation of soil contaminated with oil spills. ▪ Biodegradation: Assimilation, Detoxification, Activation, Bio-availability, Recalcitrance, Co-metabolism and Biotransformation. Factors affecting biodegradation, Predicting products of biodegradation, Biodegradation of environmental contaminants (Pesticides, Lignin, Halogenated hydrocarbons) 	08
III	<p>Environmental Monitoring</p> <ul style="list-style-type: none"> ▪ Environmental monitoring and sample analysis: Sampling of air and water pollutants; ▪ Monitoring techniques and methodology: TDS, pH, Dissolved Oxygen (DO); Chemical oxygen demand (COD); Biological Oxygen Demand (BOD); Speculation of metals, monitoring and analysis of CO, NO₂, CO₂, SO₂; Pesticide residue; Phenols and petrochemicals. 	08
IV	<p>Regulation and Environmental management</p> <ul style="list-style-type: none"> ▪ Activated Sludge Process (ASP) – Trickling Filters – oxidation ponds, fluidized bed reactors, membrane bioreactor neutralization, ETP sludge management; digesters, up flow anaerobic sludge blanket reactor, fixed film reactors, sequencing batch reactors, hybrid reactors, bioscrubbers, biotrickling filters. ▪ Regulatory framework for pollution monitoring and control; case study: Ganga Action Plan; Yamuna Action Plan; implementation of CNG in NCT of Delhi. Application of clean technologies for pollution control, hospital waste management ▪ Environment management Problems and need Environmental management Plan: Need of EMP Environmental Impact Assessment: Objectives of EIA EIA and International organizations Stages of EIA process EIA in India: Process Stages of Environmental clearance process ISO 14000 Environmental audits and ethics Environmental Laws and Policies. 	12
V	<p>Biotechnological Perspectives for Sustainable Environment</p> <ul style="list-style-type: none"> ▪ PGPR bacteria: Biofertilizers, ▪ Microbial insecticides and pesticides, bio-control of plant pathogen ▪ Development of stress tolerant plants, ▪ Biofuel: first, second and third generation ethanol, Biodiesel 	10

	<ul style="list-style-type: none"> ▪ Mining and metal biotechnology: microbial transformation, accumulation and concentration of metals, metal leaching, extraction; exploitation of microbes in copper and uranium extraction. ▪ Biosensors: Components, Types and Applications of biosensors in the monitoring of heavy metals, BOD, nitrogen compounds, polychlorinated biphenyls, phenolics and organophosphorus compounds ▪ Phytoremediation 	
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Suggested readings:

1. Evans, G. G. and Furlong J. (2010) Environmental Biotechnology: Theory and Application (2 nd edition). Wiley-Blackwell Publications.
2. Jordening H. J. and Winter J. (2005) Environmental Biotechnology: Concepts and Applications. John Wiley & Sons.
3. Ramtake D.S. and Moghe C. A. (1998) Manual on water and waste water analysis, NEERI, Nagpur.
4. Agarwal S. K. (2005) Advanced Environmental Biotechnology APH Pub Co, New Delhi.
5. Evans G.M. and Furlong J.C. (2003) Environmental Biotechnology: Theory and applications, John Wiley & Sons, England.
6. Sayyed, R.Z. Reddy M. S. and Antonious Sarjiya (2019) Plant Growth Promoting Rhizobacteria (PGPR): Prospects for Sustainable Agriculture, Springer-Nature, ISBN 978-981-13-6789-2.
7. Tiwari G.N. and Mishra R K (2012) Advanced Renewable Energy Sources, RSC Publishing, London.

BT-304: Methods in Plant Biotechnology

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	Extraction of secondary metabolites
7	Micropropagation of Banana/ Citrus /Papaya/ Sugarcane etc.
8	Preparation of synthetic seeds by embryo - Alginate encapsulation method
9	Preparation of competent cells
10	Transformation by calcium chloride method
11	Screening of bacterial colonies using X-gal and IPTG
12	Demonstration of Southern blot/ Northern blot / Western blot
13	Demonstration of PCR process
14	Electrophoresis of DNA

Note: Mandatory to perform 12-13 experiments out of 14

Suggested readings:

1. Smith R.H. (2012) Plant Tissue Culture: Techniques and Experiments, Academic Press, London
2. Madhan Shankar R. and Majesh E. M. (2013) A Practical Manual on Basic Techniques in Biotechnology and Nanotechnology, International E – Publication, Indore (ISBN: 978-81-927544-6-8)
3. Mitra Sandhya (2000) Genetic Engineering, Macmillan Publication India
4. Aneja K.R. (2001) Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Cultivation by, 2nd Edition, Wishwa Prakashan, New Age International Pvt. Ltd., New Delhi.
5. Reinert J. and Yeoman M.M (1989) Plant Cell and Tissue Culture: A Laboratory Manual, Springer-Verlag
6. Henry R.J. (1997) Practical application of Plant Molecular Biology, Chapman and Hall
7. Murray E.T. (1991) Gene Transfer and Expression Protocols - Methods in Molecular Biology, Vol. 7, Humana Press

8. Glover D.M. and Hames B.D. (1995) DNA Cloning: A Practical Approach, IRL Press, Oxford

BT-305: Methods in Environmental Biotechnology	
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 (Kjeldahl's method)
4	Vermicomposting of feedstock waste substrates in laboratory and its chemical analysis
5	Determination of soil microbial activity by CO ₂ evolution method
6	Determination of MIC of pesticide / heavy metal against bacterial culture
7	Solid state fermentation: Lab scale production of a product
8	Testing of cytotoxicity of pesticides polluted water using onion root tip assay/pollen germination
9	Biosorption of dyes or metals using dead biomass of <i>Aspergillus niger</i> or brewer's yeast (heat killed) examined for biosorption (Congo Red).
10	Synthesis of nano-particles using Biological process
11	Detection of nanoparticles in colloidal solutions using UV-Vis absorption
12	Comet assay to assess the DNA damage due to pesticide exposure
13	Estimation of metal content in soil, compost, vegetables, drinking water and waste waters using atomic absorption spectroscopy
14	Estimation of Biodiversity Index of particular habitat
Note: Mandatory to perform any 12 -13 experiments	
Suggested readings:	
1. Glick B.R., Pasternak J.J., Patten C. L. (2010) Molecular Biotechnology, 4 th edition, ASM Press, USA	
2. Sulabha K. Kulkarni, (2009) Nanotechnology; Principals and Practices, Capital Publishing Company, New Delhi.	
3. Michael A. Stroschio and Mitra Dutta. (2004) Biological Nanostructures and Application of Nanostructures in Biology, Kulwer Academic Publishers, UK.	
4. Kenneth Sauer, (1995) Biochemical Spectroscopy. Methods in Enzymology Vol 46, Academic Press, USA.	
5. Rodney Boyer, (2000) Modern Experimental Biochemistry. 3 rd edition, Prentice Hall Publisher, USA.	

BT- 401 Food and Pharmaceutical Biotechnology		
Unit	Topics	Lectures
I	<ul style="list-style-type: none"> ▪ 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: Methods of food preservation (low temperature, high temperature, osmotic pressure, dehydration), Food irradiation, ▪ Food additives Preservatives, colour, emulsifiers and stabilizers 	10
II	<ul style="list-style-type: none"> ▪ Technology of typical food and food products: Dairy products, bread, fruit beverages, flesh foods, marine 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, Nutrient labelling 	10

	<ul style="list-style-type: none"> ▪ New trends in foods: Introduction, Soya foods, Food fads, Organic foods, Edible films ▪ Food related hazards, microbiological considerations in food safety, effect of processing and storage on microbial safety, HACCP-a method to prevent food borne illness, chemical hazards associated with foods 	
III	<ul style="list-style-type: none"> ▪ Genetic engineering of baker's yeast ▪ Biotechnology of wine yeast ▪ Biotechnology of β- carotene from <i>Dunaliella</i> ▪ SCP: Spirulina and Chlorella ▪ Bacterial cellulase for clarification of fruit juices ▪ Food pathogens, toxins and their detection in food ▪ ELISA assays for detection and quantitation of toxins in foods ▪ Biosensors for food quality assessment ▪ Fermented foods and its Safety aspect 	10
IV	<ul style="list-style-type: none"> ▪ Pharmacological classification of drugs, mechanism of drug action on human beings, receptor pharmacology, factors modifying drug action, adverse effects of drugs and drug toxicology ▪ Analysis of pharmaceuticals using physical, chemical and biological methods, quality assurance and control, stability of pharmaceutical products, Quality control and testing as per Indian/US Pharmacopoeia ▪ 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 	10
V	<ul style="list-style-type: none"> ▪ Biopharmaceuticals of animal, plant and microbial origin ▪ Hematopoietic growth factors and coagulation factors ▪ Interferons and cytokines for anti-infective and cancer therapy ▪ Insulin and growth hormones ▪ Genetically improved vaccines ▪ Recombinant thrombolytic agents: Tissue type plasminogen activator ▪ Gene therapy, <i>Ex vivo</i> and <i>In vivo</i> gene therapy, Antigen and antisense therapy 	10
Suggested readings:		
<ol style="list-style-type: none"> 1. Gerald Reed (1983) Prescott and Dunn's Industrial Microbiology, 4 th Edition, AVI Publishing Company Inc. Connecticut 2. Knorr, D. (1982, 1987) Food Biotechnology, 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. (1998) The Technology of Dairy Products, 2 nd Edn, Blackie Academic and Professional, UK 6. Belits H.-D. and Grosch W. (1999) Food Chemistry, 2nd Edition, Springer Verlag, Germany 7. Spencer J.F.T. and de Spencer A.L.R. (2001) Food Microbiology Protocols, Humana Press 8. Garry W. (2004) Biopharmaceuticals: Biochemistry and Biotechnology, 2nd Edition, John Wiley and Sons, England 		

9. Rodney J.Y., Ho and Gibaldi M. (2003) *Biotechnology and Biopharmaceuticals: Transforming Proteins and Genes into Drugs*, Wiley- Liss, A John Wiley and Sons, Inc., New Jersey
10. Zito S.W. (Ed) (1997) *Pharmaceutical Biotechnology: A Programmed Text*, 2 nd Edition, Technomic Publishing Co., Inc., USA.
11. Klefenz, H. (2002) *Industrial Pharmaceutical Biotechnology*, Wiley –VCH Verlag GmbH.
12. Walsh, G. (2003) *Biopharmaceuticals-Biochemistry and Biotechnology*, John-Wiley
13. Propst C.L. and Perun T.J. (Eds) (1992) *Nucleic Acid Targeted Drug Design*, Blackwell Synergy
14. Reece R.J. (2004) *Analysis of Genes and Genomes*, John Wiley and Sons, Ltd., England
15. Manay, S. and Shadaksharaswami, M. (2004) *Foods: Facts and Principles*, New Age Publishers.
16. Fennema. O R. (2006) *Food Chemistry*, Marcel Dekker, Inc, New York.
17. Sun DW. (2005) *Emerging Technologies for Food Processing*, Academic Press, NY

BT - 402: Bioinformatics		
Unit	Topic	Lectures
I	Introduction to biological databases <ul style="list-style-type: none"> ▪ Concept and Applications of Bioinformatics ▪ Biological Databases: Concept, types, specialization, limitations, ▪ NCBI, PUBMED, ▪ Sequence databases: Gene bank, DDBJ, Swiss prot, PIR, EMBL, ▪ Structural databases: PDB, MMDB, specialized databases, ▪ Sequence retrieval system - SRS, ENTREZ, Expasy 	10
II	Sequence and Phylogenetic analysis <ul style="list-style-type: none"> ▪ Sequence alignment: local, global, pair wise and multiple sequence ▪ Sequence and similarity: FASTA, BLAST, ▪ Introduction to scoring matrices: PAM and BLOSSUM, ▪ Introduction to phylogenetic trees ▪ Protein structure prediction: Secondary structure prediction, 3D Structure prediction 	10
III	Genomics <ul style="list-style-type: none"> ▪ Concept of 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 ▪ DNA microarray: Concept, method, advantages and disadvantages 	10
IV	Proteomics <ul style="list-style-type: none"> ▪ Concept of Proteomics, application, advantages and limitations of Expressional Proteomics <ul style="list-style-type: none"> • Ramachandran plot, protein secondary structure prediction, Chou-Fasman and GOR method, Neural networks • Techniques in Proteomics • 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 	12

	<ul style="list-style-type: none"> Protein three-dimensional structure prediction: Homology modeling and protein Threading, Molecular visualization, Computer aided drug design, Docking and QSAR Peptide analysis: MALDI-TOF, Application of proteome analysis to drug development Protein chips Protein micro-array, Concept, method, advantages and disadvantages 	
V	Data Mining and Data Visualization <ul style="list-style-type: none"> Concept of Data Mining and its application in Bioinformatics Software for Data Visualization: CN3D, Rasmol Mol, Pymol, Chimera, SWISS PDB Viewer, DISCOVERY STUDIO, and MODELLER, Introduction to Bioperl and Biojava, Online Free web resources 	08

Suggested readings:

- Durbin R, Eddy S R., Krogh and Graeme Mitchison (2013) Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids, Cambridge University Press.
- Baxevanis A D., Francis B. F. (2000) Ouellette, Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, Second Edition, Wiley-Interscience
- 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. Edn.), Garland Publishing, NY, USA.
- Mount, David, W. (2004) Bioinformatics: Sequence and Genome Analysis, 2nd edition, Cold Spring Harbor Lab. NY.
- Ghosh Z, and Mallick B. (2008) Bioinformatics: Principles and Applications, Oxford University Press.
- Pennington, S, and Dunn, M. J. (2001) Proteomics: From Proteins Sequence to Function, Springer Publications.
- Timothy Palzkill (2002) Proteomics, Kluwer Academic Publishers
- Sandor Suhai, (2002) Genomics and Proteomics: Functional and Computational Aspects, Plenum Publication Corporation.
- Jones, Neil and Pavel Pevzner; (2004) An Introduction to Bioinformatics Algorithms: A Bradford Book, The MIT Press, USA
- Xiong Jin (2006) Essential Bioinformatics, 1st edition, Cambridge University Press

BT-401: Industrial and Business Biotechnology		
Unit	Topics	Lectures
I	Microbial Production of Organic acids: Citric acid, Gluconic acid, Acetic acid, Lactic acid Production of alcohol by yeast fermentation Production, recovery and applications: Glycerol, Acetone and Butanol,	10
II	Microbial Production, recovery and applications: Amino acids: L-Glutamic acid, L-Lysine, L-Phenylalanine and L-Tryptophan, L-Threonine. Vitamins: Vitamin-B ₁₂ and Riboflavin Antibiotics: Penicillin, Streptomycin, Tetracycline, Erythromycin, Peptide antibiotics	10
III	General features of microbial polysaccharides, Chemistry and properties Production, recovery and applications of polysaccharides: Xanthan, Dextran and Alginate, Polyhydroxy-alkanoates Polyhydroxy-butyrate (PHB), Biopol-a biodegradable plastic,	10

	Microbial recovery of petroleum.	
IV	Production and applications of Amylases, Proteases, Pectinases, Cellulases, Lipase, Glucose isomerase, Penicillin acylase, Asparaginase Microbial transformation, Types of bioconversion reactions: Oxidation, Reduction, Hydrolytic reactions, Condensations, Transformation of steroids and sterols. Transformation of non-steroidal compounds: L-ascorbic acid, Prostaglandins, Antibiotics.	10
V	Principles of management, Marketing concepts and functions, Advertising and promotion, Principles of sales management, Time event-time study (CPM and PERT), ISO 9000 quality system standards, Entrepreneurship: Concept, Nature and Scope, Importance of entrepreneurship and self-employment, Entrepreneurship and principles of entrepreneurial development, Qualities of an entrepreneur, Functions and types of entrepreneur Pricing and promotion, Franchising, Biosafety: Guidelines and regulations, Biosafety for human health and environment, Bioethics: Necessity, different paradigms of bioethics, Intellectual property and IPR: patent, copyrights, geographical indications, trademarks, trade secret, Industrial designs, Patent law, Legislations covering IPR's in India, product planning and development, filing patent, provisional and complete specification, patentable and non-patentable items, Valuation and business concerns	10

Suggested readings:

- Arnold L. Demain and Julian Davies (1999). Manual of Industrial Microbiology and Biotechnology, 3rd Edition, ASM press, Washington DC.
- Frazier, W. C., and Westhoff, D. C. (1967). Food Microbiology Mc-Graw-Hill Book Company, New York.
- Casida L. E. (1991) Industrial Microbiology, John Wiley and Sons Inc, New York
- Stanbury, P. F., Whitaker, A., and Hall, S. J. (2013) Principles of Fermentation Technology, Elsevier.
- Gupta P.K. (2004) Biotechnology and Genomics, Rastogi Publications, Meerut, India.
- Singh K. Intellectual Property Rights on Biotechnology. BCIL, New Delhi.
- Dando M.R. (1994) Biological Warfare in the 21st Century. Potomac Books Inc; ISBN-10: 1857530640
- Harold K. and Heinz W. (2003) Essentials of Management, 5th Edition, Tata McGraw-Hill, New Delhi.
- Narayana V. and Sreenivasan N.S. (1996) Quality Management: Concepts and Tasks. New Age International, New Delhi.
- Crueger W and Crueger A, (2000) Biotechnology: A Textbook of Industrial Microbiology, Panima Publishing Corporation, New Delhi.
- Patel A.H. (2004) Industrial Microbiology, Macmillan India Ltd., New Delhi.
- Pepler H.J and Perlman D. (2006) Microbial Technology, Vol I and II, Academic Press, New York.
- Desai, V. (2007) Dynamics of Entrepreneurial Development and Management, Himalaya Publishing House.

BT- 404: Methods in Biotechnology

1	Validation of autoclave/ Laminar air flow.
2	Analysis of milk and milk products – Lactose/ Protein/ Phosphorus and Calcium content of milk powder
3	To check the sterility of pharmaceutical product. (Injectable/ Parental/ Ophthalmic preparations)

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	Microbial assay of vitamin /antibiotics
7	Production and isolation of bacterial exo-polysaccharides from bacteria
8	Production and estimation of alkaline protease from bacterial source
9	Production and estimation of bacterial/ fungal lipase
10	Production of sauerkraut by microorganisms
11	Biological databases – NCBI, Protein Data Bank and ExPasy
12	Pair wise alignment of DNA and Protein
13	Multiple sequence alignment of DNA and Protein
14	Secondary structure prediction of proteins

Note; Mandatory to perform 12-13 experiments

Suggested readings:

1. White, D (2000) The Physiology and Biochemistry of Prokaryotes, Oxford University Press, Oxford.
2. Mudili, J (2007) Introductory Practical Microbiology, Narosa Publ. House Pvt. Ltd., New Delhi (ISBN: 978-81-7319-744-4).
3. Primrose, SB and Wardlow, AC (1982) Source Book for Experiments for the Teaching of Microbiology, Academic Press, London (ISBN: 0-12-565680-7).
4. Sawhney, SK and Singh, R. (2001) Introductory Practical Biochemistry, Narosa Publ. House, Chennai.
5. Bailey, N.T.J (1959) Statistical methods in Biology, ELBS and The English Universities Press Ltd., UK.
6. Irfan Ali Khan and Atiya Khanum (2004) Fundamentals of Biostatistics, Ukaaz Publication, Hydrabad.
7. Baxevanis, A. D. and Ouellette, B. F. F. (2001) Bioinformatics: A Practical Guide to the Analysis of genes and proteins. Second Edition. John Wiley and Sons, New York.
8. Ewens Warren J. and Gregory R. Grant. (2004) Statistical Methods in Bioinformatics, An Introduction, Springer, New York.
9. Lacroix, Z. and Critchlow, T. (Eds.) 2003. Bioinformatics. Managing Scientific Data, Morgan Kaufmann Publishers.
10. Misener, S. and Krawetz, S. A. (Eds.) (2000) Methods in Molecular Biology, Volume 132, Bioinformatics: Methods and Protocols. Humana Press, New Jersey.
11. Mount, D. W. (2001) Bioinformatics: Sequence and genome analysis. Cold Spring Harbor Laboratory Press, New York.

BT-405: Biotechnology Practical (Project Dissertation Work)

The project is allotted during the Forth semester. The students will get an opportunity to become a part of ongoing research activities in the respective College. The student will explore and gain experience in different sectors of biotechnology viz agriculture, food, medicine and pharmaceutical. The students will acquire skill to write, compile and analyze data, and present the detailed technical/scientific report. At the end of successful project semester training, potentially the students become employable in the industries/organizations.

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 on the topic of research from libraries, internet, on-line journals, Planning of research experiments
3. Performing the experiments with scientific and statistical acceptability.

4. Presentation of observations and results.
5. Interpretation of results and drawing important conclusions.
6. Discussion of obtained results with respect to literature reports.
7. Writing monthly progress report
8. Preparation of report (Dissertation) containing introduction, materials and methods, results and discussion, conclusions, bibliography and submission of at least 3 copies (1 copy retained in the department and after examination submitted to Library, 1 copy submitted to the guide and 1 copy kept with the candidate).
9. Presentation of research data during university examination and submission of project dissertation in a bound form.

1. **Internal examination** (40 marks): Components of continuous internal assessment
Submission of monthly progress report and signed by supervisor (at least 4 reports) (2 marks per report = 8 marks), Literature collected, experiment planning and design (10 marks), Experiments conducted (10 marks), outcome of the experiments and viva (8 marks) and regular attendance (4 marks) recorded:
Research Supervisor
2. **External examination** (60 marks) and Components of external assessment:
Subject matter (5 marks), Review of literature (10 marks), Writing of dissertation submitted in bound form at the time of examination (Title page, Certificate, Plagiarism report, Main content: Abstract, Introduction, Literature, Materials and methods, results and discussion and conclusion with relevant references) (15 marks), Presentation structure (PPT format) (8 marks), Overall presentation reflecting contribution of work (4 marks), Response to questions (15 marks).

Suggested readings: Refer to the journals, reference books, abstracts etc. related to topic