Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Biotechnology

Curriculum

For the Academic Year 2018-19

Two Year Degree Programme in Biotechnology

(Four Semester Programme)

(CC/DSE/SEC)

PG Second Year

Semester III and IV

Syllabus Approved by Board of Studies in Biotechnology with effect from June, 2018

Rajarshi Shahu Mahavidyalaya, Latur
(Autonomous)
Department of Biotechnology
Choice Based Credit System
Course Structure of M.Sc. Biotechnology Second Year

M. Sc. II [Biotechnology] Semester III

Code No.	Title of the course	Hours/ Week	Marks (100)		Credits
			In Sem	End Sem	
P-GEE-334	Genetic Engineering	04	40	60	04
P-MIB-335	Microbial Biotechnology	04	40	60	04
P-EPE-336	Enzyme Technology and Protein Engineering	04	40	60	04
P-PLB-337	Plant Biotechnology	04	40	60	04
P-LAC-338	Lab Course IX (Practical based on BTTT 3.1)	04	20	30	02
P-LAC-339	Lab Course X (Practical based on BTTT 3.2)	04	20	30	02
P-LAC-340	Lab Course XI (Practical based on BTTT 3.3)	04	20	30	02
P-LAC-341	Lab Course XII (Practical based on BTTT 3.4)	04	20	30	02
P-ADC-342	Research Methodology and Scientific Report Writing	03	20	30	02
	Total Credits	**35**			**26**

M.Sc. II [Biotechnology] Semester IV

Code No.	Title of the course	Hours/ Week	Marks (100)		Credits
			In Sem	End Sem	
P-GEM-432	Genomics and Proteomics	04	40	60	04
P-PHB-433	Pharmaceutical Biotechnology	04	40	60	04
P-FOB-434	Food and Nano Biotechnology	04	40	60	04
P-ENB-435	Environmental Biotechnology	04	40	60	04
P-LAC-436	Lab Course XIII (Practical based on BTTT 4.1 + BTT 4.2)	04 +04	20	30	02
P-LAC-437	Lab Course XIV (Practical based on BTTT 4.3 + BTT 4.4)	04+04	20	30	02
P-PRW-438	Lab Course XV Dissertation	04		100	04
	Total Credits	**36**			**24**

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M.Sc. Biotechnology
III Semester

Course Title: Genetic Engineering **Course Code: P-GEE-334**
Marks 100 **Lectures: 60** **Credit: 04**

Learning Objectives:

- To illustrate the creative use of modern tools and techniques for the manipulation and analysis of genomic sequences.
- To expose students to the application of recombinant DNA technology in biotechnological research.
- To train students in strategizing research methodologies employing genetic engineering techniques.
- To gain an understanding of basic molecular and cellular biology concepts and techniques.

Course outcomes:

On the successful completion of the course, students will be able to-

- understand the application of genetic engineering techniques in basic and applied experimental biology.
- design and conduct experiments involving genetic manipulation.
- describe DNA fingerprinting, and restriction fragment length polymorphism (RFLP) analysis and their applications.
- describe the steps involved in the production of biopharmaceuticals in microbial and mammalian cell systems.

Unit-I **(14 L)**

Introduction

Isolation of DNA and RNA. Quantification of nucleic acids. Radiolabeling of nucleic acids: End labelling, nick translation, labelling by primer extension, DNA sequencing: Maxam- Gilbert (Chemical) and Sanger-Nicolson(dideoxy/enzymatic) sequencing method, Pyrosequencing.

Unit-II **(16 L)**

Tools

Restriction endonucleases: Types of restriction endonucleases, classification and uses. Restriction mapping. DNA modifying enzymes: Nucleases, Polymerases, Phosphatases and DNA ligases. Prokaryotic host. Plasmid vectors, Bacteriophage, other vectors, expression vectors, Construction of genomic and c-DNA libraries, Joining of DNA Fragments tovectors, Homo polymer tailing, cohesive and blunt end ligation, adaptors, linkers.

Unit-III **(13 L)**

Techniques

Selection, screening, and analysis of recombinants. Principle of hybridization. Northern blotting, Southern blotting, Western blotting. Polymerase chain reaction, Restriction fragments length polymorphism, RAPD, AFLP, MAP.

Unit-IV **(17 L)**

Engineering

Vector Engineering and codon optimization, host engineering. Strategies of gene delivery, *in vitro* translation, expression in bacteria and yeast, expression in insects and insect cells, expression in mammalian cells, expression in plants. Chromosome engineering, Targeted gene replacement, gene editing, gene regulation & silencing.

Recommended Textbooks and References:

1. Principles of Gene manipulation (1994) 5th Edition, Old R.N. and Primrose S.B.
2. From Genes to Clones (1987) Winnaeker E.L., Wiley VCH publication
3. Recombinant DNA (1992) 2nd edition, Watson J.D., Witreowski J., Gilman M. And Zooller M., W.H. Freeman & co. Ltd.
4. An Introduction to Genetic Engineering (2008) 3rd edition, Nicholl, D.S.T., Cambridge university press,
5. Molecular Biotechnology (1996) 3rd edition, J. J. Pasternak, American society for microbiology,
6. The Biochemistry of Nucleic acid (1992) 11th edition, Adam et al, Springer publication.
7. Genetic Engineering (2005) Janke k. swtlow, Springer publication.

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Course Title: Lab Course IX **Course Code: P-LAC-338**

Marks 50 **Credit: 02**

Learning objectives:

- To Provide Hands-on isolation and purification of Nucleic Acids.
- To Provide Hands-on Quantitative Analysis of Nucleic acids.
- To Provide Hands on Advanced molecular techniques used in research.
- To Provide Skills on designing of primers using online tools.

Course outcomes:

On the successful completion of the course, student will be able to-

- perform PCR, Blotting, molecular diagnosis, cell profiling etc...
- study genetic diversity of prokaryotes and eukaryotes.
- analyze DNA fingerprinting.
- provide solution at molecular level for diagnosis of current issues in health care.

Practicals:

1. Isolation of nuclei and analysis of chromatin- i) determination of mono-nucleosome size ii)chromatin gel electrophoresis
2. Endonuclease digestion of nuclei and analysis of DNA fragments by agarose gel electrophoresis
3. Thermal melting of DNA
4. Isolation of plasmid DNA-i) mini preparation ii) large-scale isolation
5. In *vitro* DNA ligation, transformation of *E.coli.*
6. Techniques: a) DNA blotting technique b) DNA hybridization.
7. Isolation of cytoplasmic RNA.
8. Electrophoresis of RNA on denaturing gels.
9. Northern blotting technique
10. Separation of poly A+RNA on oligo-dT column.
11. cDNA synthesis and cloning.
12. RNA hybridization-dot and northern blots.
13. In *situ* detection of RNA in embryos/tissue.
14. *In vitro* translation.
15. Sequencing and computer analysis.
16. PCR/RFLP technique.

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III Semester

Course Title: Microbial Biotechnology **Course Code: P-MIB-335**
Marks: 100 **Lectures: 60** **Credit:04**

Learning Objectives:

- To impart knowledge about biological products, design & operation of industrial processes.
- To outline the technology used in industry for Large Scale production of industrially important products.
- To understand general overview, concepts and basic principles with emphasis on Upstream Processing of Industrial Products.
- To understand general overview, concepts and basic principles with emphasis on Downstream Processing of Industrial Products.

Course Outcomes:

On the successful completion of the course, student will be able to-

- understand the various concepts of fermentation process, Recombinant Technology and Biotransformation
- demonstrate production of Industrial Products such as Organic acids, Solvents, antibiotics, vitamins, polysaccharides, biopolymers, Enzymes, Amino acids etc
- explain commercialization of industrial products
- start a piolet scale industrial plant

Unit-I: (16 L)

Microbial Production, Recovery and Applications of Organic Acids, Solvents and Vitamins

Organic acids: Productionof Citric acid and Lactic acid, **Organic Solvents:** Acetone; Ethanol, Glycerol, **Vitamins**: Vitamin B12 and Riboflavin.

Unit-II: (15 L)

Microbial Production, Recovery and Applications of Amino acids

Amino acids: Production of individual amino acids (L-Glutamic acid; L Lysine; L-Tryptophan)

Production of Insulin and erythropoietin by recombinant technology

Microbes in environmental applications

Biogas production from Biomass: Methane, Bioleaching: Mechanism of Bioleaching with example, Biosorption and Microbial recovery of petroleum (MEOR).

Unit-III: **(13 L)**

Microbial Production, Recovery and Applications of Antibiotics, Polysaccharides and Polyhydroxy Alkenoates

Production of Chemotherapeutic agents: Penicillin, Tetracycline and Erythromycin
Production of Microbial Polysaccharides: Xanthan, Dextran and Alginate
Production of Poly Hydroxy Alkenoates: Polyhydroxy butyrate (PHB), BIOPOL

Unit-IV: (**16 L)**

Microbial production of Enzymes:

Immobilization of enzymes, Commercial applications and production of Amylases; Proteases; Pectinases; Cellulase.

Biotransformation: Types of bioconversion reactions: Oxidation, Reduction, Hydrolytic reactions, Condensations, Transformation of steroids and sterols, Transformation of nonsteroid compounds: L-Ascorbic acid, Prostaglandins, Antibiotics.

Recommended Textbooks and References:

1. A text book of Industrial Microbiology. (2003) 2nd edition, Wulf Cruger and Anneliese Cruger., Biotechnology, Panima Publishers, New Delhi
2. Industrial Microbiology (2006), 1st Edition, Casida, J.R., L.E., Willey Eastern Ltd, New Delhi,
3. Industrial Microbiology, (1987), 4th Edition, Prescott and Dunn, CBS Publishers, New Delhi
4. Principles of Fermentation Technology, (2005), 2nd edition Stanbury, P.F., and Whitaker, A., Pergamon Press, Oxford
5. Modern Industrial Microbiology and Biotechnology, (2001), 1st edition, Nduka Okafar
6. Biotechnology. U Satyanarayana. (2005) Uppala Author Publisher Interlinks, Vijaywada, India.
7. Microbial Technology, Peppler & Perlman. Vol- I, II Academic Press
8. Basic Biotechnology, Bu'Lock J. and Kristansen B. (Eds) (1987). Academic Press Inc Ltd, London.
9. Manual of Industrial Microbiology and Biotechnology (1999) 2nd Edition, *Demain* A.L., Davies J.E. (Ed in Chief) ASM, Washington, USA.
10. Industrial Microbiology (2020) by G. Reed, 4th edition, CBS Publishers (AVI Publishing Co.)
11. Biotechnology, A Textbook of Industrial Microbiology (1990), 2nd edition, Creuger and Creuger, Sinaeur associates inc. U.S.
12. Comprehensive Biotechnology, (1987), Cooney &Humphery. Vol-3. Pergamon press.
13. Text Book of Biotechnology, (2008) 3rd edition, H.K Das, Willey India
14. Industrial Microbiology, (2011), 2nd edition, A.H Patel, Macmillan Publication.

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III Semester

Course Title: Lab Course X **Course Code: P-LAC-339**
Marks: 50 **Credit:02**

Learning Objectives:

- To Provide Hands-on Production Process.
- To Provide Hands-on Quantitative Analysis.
- To Provide Hands on Isolation and Purification of Microbiological Techniques.
- To Provide Hands-on Purification Techniques.

Course Outcomes:

On the successful completion of the course, student will be able to-

- perform Production of Industrial Products.
- perform optimization of upstream and downstream processing of industrial products.
- analyze the product quantitatively.
- perform purification and characterization of products.

Practicals:

1. Production and isolation of bacterial exo-polysaccharides
2. Production and estimation of alkaline protease from bacterial source
3. Production and estimation of bacterial lipase
4. Production of sauerkraut by microorganisms
5. Production and estimation of lactic acid by Lactobacillus Sp.
6. Production of fermented milk by *Lactobacillus acidophilus.*
7. Comparison of ethanol production using various Organic wastes /raw Material
8. Laboratory scale production of biofertilizers
9. Amylase production by bacteria
10. Amylase production by fungi

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Course Title: Enzyme Technology and Protein Engineering
Course Code: P-EPE-336
Marks 100 Lectures: 60 Credit: 04

Learning Objectives:

- The objective of the course is to provide a deeper insight into the fundamentals of enzyme structure and function and kinetics of soluble and immobilized enzymes.
- To study current applications and future potential of enzymes.
- To study the enzymes and its enzyme kinetics.
- To study enzyme immobilization and protein engineering.

Course Outcomes:

On the successful completion of the course, students will be able to-

- The student will be able to describe structure, functions and the mechanisms of actionof enzymes.
- The student will learn kinetics of enzyme catalyzed reactions and enzymeinhibitory and regulatory process.
- The student will be able to perform immobilization of enzymes.
- The student will get exposure of wide applications of enzymes and theirfuture potential.

UNIT-I (0 8 L)

Introduction To Enzymes & Enzyme Kinetics:

The Enzyme- Introduction, nomenclature and classification, applications in Industrial, Medical, Analytical,Chemical, Pharmaceutical and Food Sectors.

UNIT – II (20L)

Enzyme Kinetics:

Enzyme kinetics, Michaelis - Menten equation, Brigg's- Haldane equation, Graphical procedures in enzymology - advantages and disadvantages ofalternate plotting, estimation of constants using graphical technique, Kinetics for reversible reactions, basics of enzymatic reaction, collision theory and transition state theory and role of entropy in catalysis, presteady state kinetics, Significance of Vmax and Km, Kinetics of multi- substrate reactions, Allosteric enzymes – The Monad – Changeux – Wyman model (MCW) and The Koshland – Nemethy – Filmer (KNF) model, Enzyme inhibition - types of inhibitors- competitive, non-competitive and uncompetitive, their mode of action and experimental determination. Enzyme activity, international units, specific activity, turnover number, end point kinetic assay.

UNIT-III (15 L)

Effect of Physical Factors & Enzyme Kinetics in Biphatic Reaction: Temperature dependence of rate constants of enzymatic reaction, thermal deactivation, pH effect on rate constants and protein structure. pH dependence: ionization of Acids and Bases. Enzyme kinetics in biphasic liquid systems, stabilization of biphasic aqueous-organic systems, equilibria in biphasic aqueous-organic systems.

UNIT-IV (17 L)

Enzyme Immobilization, Kinetics Of Immobilization & Protein Engineering: Immobilization of Biocatalysts an Introduction, Electrostatic Effect, effect of charged and uncharged support, Kinetics of immobilized enzymes –Effect of external and internal mass transfer, Damkohler number, effectiveness factor, Intraparticle diffusion kinetics, Biotnumber.Biosensors - glucose oxidase, cholesterol oxidase, urease and antibodies as biosensors, Introduction to protein engineering, structure prediction sequence structure relationship. Recombinant proteins using fusion protein strategies for enhanced recovery, Engineering protein for the affinity purification, (engineering of streptavidin) Stabilization of enzymes by protein engineering (eg. pseudomonas isoamylase)

Recommended Textbooks & References:

1. Biochemical Engineering Fundamentals (2017) 2nd edition, Bailey JE, Ollis, DF, McGraw Hill Education.
2. Biochemical Engineering (1995), Marcel Decker Blanch HW and Clark DS, University of California.
3. Bioreaction Engineering, modeling and control (2000), Schugerl K., Bellgart KH (Eds): Springer-Verlag, Berlin.
4. Enzymes (2008), palmer, East west publication
5. Handbook of Enzyme Biotechnology (1995), 3rd Edition, Wiseman, A: Ellis Horwood Publication
6. Bioprocess technology, kinetics and reactors (2011) Moser, A: Springer Verlag
7. Biochemical Engineering Principles and functions (2012) SyedTrnveer AhmedInamdar, PHI Learning Private limited.

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III Semester

Course Title: Lab Course XI **Course Code: P-LAC-340**
Marks 50 **Credit: 02**

Learning Objectives:

- To provide hands on isolation of high yielding microbial strains for the commercially important enzyme production.
- To train students for standardizing medium composition for enzyme production.
- To introduce students for the development of enzyme assay methods.
- To provide hands on gel filtration method for determination of molecular weight.

Course Outcomes:

On the successful completion of the course, students will be able to-

- the student will learn kinetics of enzyme catalyzed reactions and enzyme inhibitory andregulatory process.
- the student will be able to perform immobilization of enzymes.
- the student will get exposure of wide applications of enzymes and their future potential
- the students will be able to carry out enzyme isolation and purification protocols.

Practicals:

1. Isolation of high yielding microbial strains for the production ofcommercially important enzymes.
2. Production of commercially important enzymes from microbial sources.
3. Standardization of medium composition for the optimum production of enzymes.
4. Determination of enzyme activity and specific activity.
5. Partial purification of isolated enzymes.
6. Characterization of enzymes-Effect of pH, temperature, and inhibitors on enzyme activity etc.
7. Molecular weight determination of enzyme by Gel filtration method.
8. Method of checking the purity of the enzyme -SDS-PAGE
9. Immobilization of enzymes –Different Techniques such as adsorption, entrapment,encapsulation and cross- linking.
10. Strain improvement techniques- physical, chemical and geneticmanipulation methods.
11. Development of enzyme assay methods.
12. Formulation of enzyme stability.

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Course Title: Plant Biotechnology **Course Code: P-PLB-337**
Marks 100 **Lectures: 60** **Credit: 04**

Learning Objectives:

- The course is designed to give insights in to the advancements in the field of biotechnology with respect to plants.
- After taking this course, students should be able to follow the modern techniques and their applications in crop improvements, such as tissue culture and transgenics.
- To study genetic engineering of plants and mechanism of gene transfer.
- To study Crops with resistance to biotic and abiotic stresses.

Course Outcomes:

On the successful completion of the course, student will be able to-

- initiate and maintain callus and suspension cultures.
- explain principle, concept, and applications of somatic embryogenesis.
- explain strategies for gene transfer in plants
- compare Crops with resistance to biotic and abiotic stresses.

UNIT I **(14L)**

Plant Tissue Culture-I

Introduction to cell and tissue culture

Tissue culture media: Types, Composition and Preparation. Initiation and maintenance of callus and suspension culture Organogenesis: Principles Concept and Applications of Somatic embryogenesis, Shoot Tip, Culture, Rapid clonal propagation and production of virus free plants.

UNIT II **(16L)**

Plant Tissue Culture-II

Protoplast culture: Importance, Isolation of protoplasts, method of protoplast culture, culture media, Growth and division of protoplast, regeneration of plants, Embryo culture and embryo rescue, Anther, Pollen, and Ovary culture for production of haploid plantsand homozygous lines, Cryopreservation, slow growth and DNA banking for germ plasm conservation Commercial application of tissue culture technology, Examples :Banana and Sugarcane.

Unit-III: **(15L)**

Plant molecular biology

Gene structure, expression, and regulation in plants, *Agrobacterium tumefaciens* and the genetic engineering of plants , Mechanism of gene transfer from *Agrobacterium* to plants, Strategies for gene transfer in plants, Molecular markers and marker assisted selection

Unit-IV: **(15L)**

Transgenic Crops

Crops with resistance to biotic stresses, viruses, fungal and bacterial diseases: strategy and examples, Crops with resistance to abiotic stresses (Herbicides and droughtconditions): strategy and examples, GM crops, medical applications of GM plants Terminator technology, Ecological risk assessment of genetically modified crops.

Recommended Textbooks & References:

1. Biotechnology and Genomics (2004), Gupta P.K., Rastogi Publications, Meerut, India.
2. Transgenic Plants: A Production Systemfor Industrial and Pharmaceutical Proteins (1996), Owen M.R.L. and Pen J. (Eds) John Wiley & Sons, England.
3. Agricultural Biotechnology (1999), *Purohit S.S., Agro* Botanica, India.
4. Plant Cell Biotechnology (1994), Endress R., Springer Verlag, German

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III Semester

Course Title: Lab Course XII **Course Code: P-LAC-341**
Marks: 50 **Credit:02**

Learning Objectives:

- To demonstrate PTC laboratory structuring with necessary explanations.
- To provide Hands on experience in media preparation
- To train students in plant tissue culture handling.
- To introduce students to experiments in plant breeding.

Course Outcomes:

On the successful completion of the course, the student will be able to-

- perform media preparation.
- handle plant tissue culture samples.
- perform plant breeding experiments.
- carry out in-vitro micropropagation of plants.

Practicals

1. Plant tissue culture laboratory design
2. Aseptic techniques
3. Media preparation
4. Micro propagation
5. Anther culture
6. Hairy root Culture
7. Plant DNA isolation
8. Protoplast isolation
9. Embryo culture
10. RAPD

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III Semester
Skill Enhancement Course

Course Title: Research Methodology and Scientific ReportWriting
Course Code:P-ADC-342
Marks:50 Lectures :30 Credit: 02

Learning Objectives:
The primary objective of this course is

- To develop a research orientation among the students and to acquaint themwith fundamentals of research methods.
- To develop understanding of the basic framework of research process.
- To develop an understanding of various research designs and techniques.
- To identify various sources of information for literature review and data collection.

Course Outcomes:
On the successful completion of the course, students will be able to-

- expose to the main components of a research framework like defining a problem, research design, data collection, scientific writing, and presentation.
- know ethical issues related to publishing, Plagiarism and Self- Plagiarism.
- know about the different types of research reports formats.
- know different techniques of sampling, estimation and checking standard errors

Unit I. (5L)
Basic Concepts, Types & Methods of Research
What is Research? Objectives of Research; Scientific Research; Importance of researchmethodology in scientific research.
Classification of Research; Pure and Applied Research; Experimental Research; Surveys; Case Study; Field Studies; Review of Literature; Need for Reviewing Literature.

Practicals Based on Unit I (5L)
1. How to search and download literature using PubMed and other NCBI Databases.
2. Literature search using Google Scholar, and Research Gate.

Unit II. Planning of Research (5L)
Selection of a Problem for Research; Hypothesis formation; Research Design/Plan; SamplingTechniques or Methods; Estimation of Standard Error.
Scientific Data; Types of Data; Methods of Collecting Primary Data; Observation Method; Experimentation, Design of Experiments; Simulation; Pilot Studies. Statistical Analysis; Probability distributions; Hypothesis Testing; Test of Significance; Measures of Relationship; Correlation and Regression; Comparison of Means(z test, t test, two sample t test, paired-ttest); ANOVA

Practicals Based on Unit II **(5L)**

1. Use of Statistical methods for analysis and data correction; Problem solving.
2. Use of Statistical Software (like SPSS/GraphPad Prism/MINITAB) for data analysisand correction

Unit III: Scientific and Medical Writing **(5L)**

Types of Reports; Research Report Format; Publications; Journals; Research Paper; Review Paper; Peer Review; Review of research papers; Impact Factors; Citations; Medical writing for doctors; Medical writing for public. Ethical issues related to publishing, Plagiarism and Self- Plagiarism; Commercialization - Copy right - royalty - Intellectual property rights and patentlaw.

Practicals based on Unit III **(5L)**

(Use of Software for formatting of the scientific reports/publications like MS Office/MS Excel. Use of Software for formatting the Bibliography/References.

1. Use of MS Powerpoint for slide preparation/Presentations

Recommended Textbooks and References:

1. Research Methodology: Methods and Techniques (1990), Kothari C. R. New AgeInternational Publishers,
2. Quantitative Techniques (2005), Kothari, C. R. New Delhi, Vikash publishing house.
3. Development of Research Tools (2004), Gautam, N. C. New Delhi Shree Publishers.
4. Research Methodology and Statistical Techniques (2005), Gupta, Santosh Deep and Deep Publications.
5. Research Methodology: a step-by-step guide for beginners Kumar (2011), R. (3rd edition).London, UK: TJ International Ltd, Padstow, Corwall.
6. Practical Research: Planning and design (1980). Leedy, P. D. Washington: Mc MillanPublishing Co., Inc.
7. Fundamental of Research Methodology and Statistics (2006). Singh, Y. K. New Delhi. NewInternational (P) Limited, Publishers.
8. Your Research Project: A step-by-step guide for the first-time researcher (2006). Wallinman, N. London: Sage Publications.
9. Statistical Methods for Research Workers by Fisher R. A., Cosmo Publications, New Delhi
10. Design and Analysis of Experiments (2001), Montogomery D.C. John Wiley.
11. An Introduction to Research Methodology (2002), Garg, B. L.Karadia R. Agrawal, F. and Agrawal U. K. RBSA Publishers.
12. Experimental Design for the Life Sciences. Ruxton & Colegrave, Oxford University Press. David J. Glass. Experimental Design for Biologists. Cold Spring Harbor Laboratory.
13. A Field Guide for Science Writers (1997). Blum, Oxford UP.
14. How to Write and Publish a Scientific Paper, Angier Best American Science Writing or Dawkins Oxford Book of Modern Science Writing.Robert A. Day and Barbara Gastel.. 6th Edition.
15. The Craft of Scientific Presentations: Critical steps to succeed and critical errors to avoid (2003). Alley, M. Springer, NY. 241 pages.
16. How to Do Everything with Microsoft Office Excel 2007, Guy Hart-Davis, McGraw-Hill Catherine Skintik, Learning Microsoft PowerPoint 2007 by Pearson Education.

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IV Semester

Course Title: Genomics and Proteomics **Course Code: P-GEP-432**
Marks 100 **Lectures: 60** **Credit: 04**

Learning Objectives:

- To understand basic and applied aspects in genomics and pharmacogenomics andproteomics
- To Understand applications of genomics and pharmacogenomics in clinical settings
- Provide an example of pharmacogenomics
- Appreciate possible ethical and legal issues

Course outcomes:
On the successful completion of the course, students will be able to-

- describe the development of Omics technologies, with emphasis ongenomics and proteomics.
- synthesize information to discuss the key technological developments thatenabled modern genomic and proteomic studies.
- describe advanced genomics and proteomics technologies and the ways inwhich their data are stored.
- use bioinformatics techniques to query examples of genomic andproteomic databases to analyze cell biology.

Unit I **(14 L)**

Introduction to Bioinformatics:

The fundamentals of protein and nucleic acid Sequence analysis, Database searching, pairwise alignments, database searching including BLAST, Multiple sequence alignments, phylogenetic analysis, Profile searches of databases, revealing protein motifs, 3D structural comparisons, predictions, and modeling.

Unit II **(18 L)**

Genomics:

What is genomics, Genetics to genomics, Whole genomes sequencing. Genome Sequence Acquisition and Analysis, Biomedical Genome Research: Genomic sequences to make new vaccines, new types of antibiotics, Next Generation Sequencing: Introduction, Types, Different platforms for NGS like Illumina, PacBio; SOLiD Applications of NGS in transcriptome analysis, genome sequencing, and exome sequencing.

Genomic Variations: Variation in the human genome, known examples of SNPs that causediseases, Pharmacogenomics, Ethical Consequences of Genomic Variations.

Unit III **(14 L)**

Expression Data Analysis:

DNA/RNA Microarrays, the oligo microarray/chip technology, Affymetrix protocol and data generation, the spotted microarray technology, cDNA and oligo spotted arrays, Biomedical applications; Cancer and genomic microarrays.

Unit IV **(14 L)**

Proteomics:

Introduction, Protein 3D Structures, Protein identifications (2-hybrid system, 2- D gel electrophoresis, mass spectrometry, Methods of ionization, M a s s analyzer ,MALDI- TOF, other arrays). Mining of protein databases, applications to human disease studies, Structural and Functional Genomics Studies, Plant Genome: Arabidopsis genome covering, Identification and Characterization of genes controlling flowering, vernalization , photoperiod and circadian clock

Recommended Textbooks and References:

1. Discovering Genomics, Proteomics, & Bioinformatics (2003). Campbell &Heyer PearsonEducation,
2. Bioinformatics, Methods of Biochemical Analysis (2001), Series Vol. 43, Baxevanis& Ouellette, John Wiley & Sons,
3. Computational Molecular Biology.Pevzner, P.A. (2000) MIT Press,
4. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins(2004). Andreas D.Baxevanis& B. F. Francis Ouellette. 3rd Edition. Wiley & Sons,

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IV Semester

Course Title: Pharmaceutical Biotechnology
Course Code: P-PHB-433
Marks 100 **Lectures: 60** **Credit: 04**

Learning Objectives:

- It is designed to equip students with a basic knowledge of concepts directly relevant to working in the biopharmaceutical industry.
- The main areas of employment for biotechnologists/ pharmacists within this sector are; Research and development, production, quality assurance and regulatory affairs.
- To impart an understanding of the terms 'traditional pharmaceutical product', 'biologic' and 'biotechnological products
- To study antimicrobial agents, antibacterial drugs.

Course Outcomes:

On the successful completion of the course, students will be able to-

- make themselves more employable in pharma industries.
- know different aspects of drug development.
- gain preliminary knowledge of clinical trials.
- understand the mechanism of action of different drugs.

UNIT -I **(15 L)**

Introduction

Chemotherapy Antimicrobial Drug. Mechanism of action of antimicrobial agents. Microbial Resistance to antibiotics and antimicrobial agents (Types and Mechanism). Types of Antibiotics: Classification of antibiotics with example. General characteristics of a Secondary Metabolites: Types and Medicinal Applications

UNIT-II **(15 L)**

Mechanism

Chemotherapeutics Agents Structure, Mechanism of Action and Applications of Antibacterial drug: Sulfonamides, Quinolones. Antiviral drug: Amantadine, Azidothymidine. Antifungal drug: Nystatin, Griseofulvin. Mechanism of action of Anticancer drugs, Drugs acting on CNS, Insulin, Blood factor VIII.

UNIT III **(15 L)**

Discovery and Development

Discovery and Development History, drug targeting, Molecular Biology and Combinatorial drug discovery, Rational Drug designing. Stability of Drug, Pharmacokinetics, Pharmacodynamics. Drug delivery systems, Liposomes.

Unit IV **(15 L)**

Clinical Trails

Clinical Trials Phases of Clinical trials of drugs, Preclinical drug evaluation of its biological activity, potency and toxicity-Toxicity test in animals including acute, sub-acute and chronic toxicity, ED50 and LD50 determination, special toxicity test like teratogenecity and mutagenecity. Biosimilar Technology, Introduction to Indian, International Pharmacopoeia and global regulatory guidelines.

Recommended Textbooks and References:

1. Pharmaceutical Microbiology - Hugo W. B. and Russell A. D. - Wiley India
2. Pharmacology and Pharmacobiotechnology- Ashutosh Kar-New Age
3. Pharmaceutical- Essentials of Pharmaceuticals- FSK Barar- S.Chand
4. Molecular Biotechnology – B.Glick and J Pasernak -ASM Press.
5. Drug Designing- Doble- McGraw Hill
6. Pharmaceutical Biotechnology- S.P. Vyas, Dixit- CBS
7. Medicinal Chemistry- B.Razdan-CBS
8. Pharmacology and Pharmacotherapeutics- Satoskar, Bhandarkar- Popular
9. Pharmaceutical Biotechnology- Purohit, Saluja- Student Edition
10. Biotechnology: Secondary Metabolites- Ramawat K.G; Merillon J.M - Oxford
11. Chemistry of Natural Products- Ed. R.H. Thomson-Springer
12. Biopharmaceuticals, Jogdand S.N - Himalaya Publishing

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M.Sc. Biotechnology
IV Semester

Course Title: Lab Course XIII (Based on P-GEP-432 and P-PHB-433)
Course Code: P-LAC-436
Marks 50 **Credit: 02**

Learning objectives:

- To train students in sequence alignment and analysis
- To provide hands-on Protein structure analysis techniques.
- To understand the phylogenetic analysis of different species.
- To provide protein function prediction on the basis of sequence and structure.

Course outcomes:

On the successful completion of the course, students will be able to-

- carry out protein structure prediction experiments.
- search and analyze genomic sequence databases using tools.
- determine Minimum Inhibitory Concentration (MIC) of Antibiotics.
- carry out sterility testing of commercial pharmaceuticals.

Pracicals:

1. NCBI - Sequence Databases & Tools
2. ISU Centers, Databases, Servers, Software
3. Sequence Alignment & Analysis
4. (BLAST, FASTA, Gene Prediction)
5. Structure Databases & Visualization
6. (PDB, PyMol, JMol, Cn3D, STING)
7. Protein Function Prediction (sequence-based, structure-based)
8. Comparative Genomics
9. Phylogenetic Analysis
10. (CLUSTAL, PHYLIP)
11. Genome Viewers, SNP Analysis
12. Microarray Analysis
13. Protein Structure Prediction
14. Proteome Analysis
15. Network & Pathway Analysis
16. Calculation of phi and psi angles in proteins.
17. Helix parameters
18. Conformational energy calculations
19. Structure validation and Protein Data Bank

20. Structural and functional motifs in proteins
21. Anatomy of protein structures
22. Examples of protein-protein and protein-DNA interactions.
23. Examples of structure-function relationship.
24. Structures of protein-protein and protein-DNA complexes.
25. Estimation of penicillin/streptomycin by biological assay.
26. Estimation of penicillin/streptomycin by chemical assay.
27. Assay of antimicrobial activity of Penicillin, Chloramphenicol, streptomycin
28. Determination of Minimum Inhibitory Concentration (MIC) of Antibiotic
29. Determination of shelf life of antibiotics (Expired drugs)
30. Sterility testing of commercial pharmaceuticals.
31. Study of microbial spoilage of pharmaceuticals.
32. Sterility testing of injectable as per IP.
33. Effect of chemical disinfectant on growth of bacteria
34. Study of Pharmacopeia and global regulatory guidelines in pharma industry
35. Study of dug action by using Zebra fish (Danio rerio) as model organism
36. Visit to Pharmaceutical industry

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IV Semester

Course Title: Food and Nano Biotechnology **Course Code: P-FNB-434**

Marks: 100 **Lectures: 60** **Credit: 04**

Learning Objectives:

- To provide basic knowledge in diverse areas of food biotechnology
- To understand the concept of food spoilage and food preservations
- To aware the students about laws and standards in food biotechnology.
- To explore the role and application of nanomaterials in various fields

Course Outcomes:

On the successful completion of the course, student will be able to -

- create awareness about different laws and standards in food biotechnology.
- acquaint with the industrial techniques used to preserve and process foods, extend their shelf-life and improve their palatability characteristics.
- gain knowledge on the various process techniques to synthesis nanostructured materials.
- get clear knowledge on the application and implementation of nanomaterials to solve the societal problems.

Unit-I: **(17L)**

Biotechnology for Food Ingredients

Metabolic engineering of bacteria for food ingredients, Biotechnology of microbial polysaccharides in food, Microbial biotechnology for food flavor production.

Aspects of Food Production.

Food safety: HACCP System to food protection, Responsibility for food safety, Food Additives: Definition, Types and Functional characteristics, Natural Colors: Types, Applications, Sweeteners: Types and Applications. Causes of food spoilage, Food Preservation Methods

Unit-II:

(13L)

Fermented Food Products and Food Applications

Fermentation technology for traditional food of the Indian subcontinent, Solid state fermentations for food applications, Genetic engineering of baker's yeast, Biotechnology of wine yeast, Biotechnology of _-carotene from Dunaliella, SCP: Spirulina and Chlorella.

Unit-III:

(16L)

Food Safety and Novel Bioprocessing

Molecular evolution and diversity of food borne pathogens, Application of microbial molecular techniques for food systems, Application of ELISA assays for

detection and quantitation of toxins in foods and *E.coli* in food, Biosensors for food quality assessment, Biotechnological approaches to improve nutritional quality and shelf life of fruits and vegetables, Biotransformation applicable to food industries, Functional foods: Concept of Prebiotics, Probiotics and Nutraceuticals.

UNIT IV (14L)

Nano Biotechnology

Nano-Biotechnology Introduction, The nanoscale dimension and paradigm. Types of nanomaterials and their classifications. D, 2D and 3D etc. Nanocrystal, Nanoparticle, Quantum dot, Quantum Wire and Quantum Well etc. Polymer, Carbon, Inorganic, Organic and Biomaterials –Structures and characteristics. Physical and Chemical Fundamentals of Nanomaterial. Green Synthesis of Nanoparticles using bacteria and plants. Characterization of nanoparticles.

Recommended Textbooks and References:

1. Food Biotechnology- Kalidas Shetty G.Paliyath, A Pometto R,E. Levin-CRC Taylor & Francis
2. Food Microbiology, Adam M.R and Moss M.O -New Age International Pub.
3. Food Microbiology, 4th Edi., Frazier W.C and Westhoff D.C -Tata McGraw Hill
4. Food Processing and Preservation, Sivsankar B, Prentice Hall of India
5. Food Biotechnology. Knorr D. (Ed) - Marcel Dekker, Inc.,
6. Food Microbiology Protocols. Spencer J.F.T. and de Spencer A.L.R. -Humana Press.
7. Modern Food Microbiology (1992), 4th Ed. Jay J.M. Chapman and Hall,New York,NY, USA.
8. Bio-Nano technology concept and applications, Madhuri Sheron, Sunil Pande- AneBooks New Delhi
9. Nanotechnology- Mark Ratner, Daniel Ratner-Pearson
10. Nanotechnology- an Introduction- Ramsden-Elsevier

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M.Sc. Biotechnology
IV Semester

Course Title: Environmental Biotechnology Course Code: P-ENB-435
Marks 100 Lectures: 60 Credit: 04

Learning Objectives:

- To have an understanding of the ecology & environment
- To know types of pollution & related pollutants.
- To help students understand biotechnological processes for the betterment of the environment.
- To learn about advancements in environmental technology.

Course Outcomes:

On the successful completion of the course, the students will be able to –

- describe existing concepts of ecology.
- describe biotechnological solutions to address environmental issues of pollution.
- explain emerging technologies that are important in the area of environmental biotechnology.
- explain remote sensing & GIS.

Unit I (14L)

Ecology & Environment:

Ecosystem structure and functions, abiotic and biotic component, Energy flow, food chain, food web, Ecological Pyramids-types, Biogeochemical cycles, Ecological succession, Ecads and ecotypes, Sustainable management, and conservation of environment.

Unit II (13L)

Environmental Pollution:

Classification of pollutants, Air pollution and their properties, Gaseous pollutants, Water pollutants and their properties, Environmental pollution and associated hazards to crops, animals and humans, Greenhouse effect and global warming. Climate Change-International conventions and global initiatives, Environmental Laws and Policies.

Unit III (18L)

Biotechnological processes:

Waste water treatment plant- Physical, Chemical and Biological unit operations /processes-overview, Activated Sludge Process, Trickling Filters, anaerobic biological treatment process.

Biotechnology in Remediation:

Introduction to bioremediation, Advantages, limitations and applications Types of Bioremediations: Microbial bioremediation- Natural, Engineered, Ex-situ and in- situ Phytoremediation, Bioaugmentation, Biostimulation, Bioconversion, Bioaccumulation, Bioconcentration, Biomagnification and Biodegradation.

Energy and Biofuels: Non-Conventional or Renewable sources of energy, Energy from Biomass, Biosensors and Biochips, Biofilters, Biofuel Cells.

Unit IV (15L)

Advancement in environmental technology:

Remote sensing and GIS- Principal, terminologies, and objectives. Energy sources for

remote sensing, Types of remote sensing. Applications- Agricultural, Forestry, Water Resource, Urban Planning, Wildlife Ecology, Disaster Assessment. Environmental Impact Assessment: Introduction, Objectives, Classification,Guidelines, Case Study.

Recommended Textbooks and References:

1. Environmental Biotechnology (2005) 2nd edition - Allan Scragg. OUP Oxford publication,
2. Environmental Biotechnology (2010) by Prof. Jogdand, Himalayan publication
3. Environmental Biotechnology, (1987) Foster C.F., John Ware D.A., Ellis Horwood Ltd.
4. Biotechnology and Biodegradation, (1990)Karrely D., Chakrabarty K., Omen G.S., Portfolio Publishing Co Inc.,U.S.,
5. Bioremediation engineering; design and application (1994) John. T. cookson,Jr. Mc Graw Hill, Inc.
6. Environmental Biotechnology (2011) 3rd edition by A.K. Chatterjee, Prentice Hall India Learning Private Limited
7. Environmental Biotechnology (2007) Bimal Bhattachraya and Ritu Banerjee, Oxford university press
8. Environmental pollution control engineering. (2021) 4th edition, C. S. Rao, New age International Publishers.
9. Environmental Biotechnology theory and application (2002) 1st edition, by Gareth Evans and Judith Furlong. John Wiley and Sons Ltd.
10. Environmental Biotechnology Concept and application (2004) 1st edition, edited by Hans-Joachim Jördening and Josef Winter. Wiley VCH Verlag GmbH & Co. KGaA

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IV Semester

Course Title: Environmental Biotechnology Course Code: P-ENB-435
Marks 100 Lectures: 60 Credit: 04

Learning Objectives:

- To have an understanding of the ecology & environment
- To know types of pollution & related pollutants.
- To help students understand biotechnological processes for the betterment of the environment.
- To learn about advancements in environmental technology.

Course Outcomes:

On the successful completion of the course, the students will be able to –

- describe existing concepts of ecology.
- describe biotechnological solutions to address environmental issues of pollution.
- explain emerging technologies that are important in the area of environmental biotechnology.
- explain remote sensing & GIS.

Unit I (14L)

Ecology & Environment:

Ecosystem structure and functions, abiotic and biotic component, Energy flow, food chain, food web, Ecological Pyramids-types, Biogeochemical cycles, Ecological succession, Ecads and ecotypes, Sustainable management, and conservation of environment.

Unit II (13L)

Environmental Pollution:

Classification of pollutants, Air pollution and their properties, Gaseous pollutants, Water pollutants and their properties, Environmental pollution and associated hazards to crops, animals and humans, Greenhouse effect and global warming. Climate Change-International conventions and global initiatives, Environmental Laws and Policies.

Unit III (18L)

Biotechnological processes:

Waste water treatment plant- Physical, Chemical and Biological unit operations /processes-overview, Activated Sludge Process, Trickling Filters, anaerobic biological treatment process.

Biotechnology in Remediation:

Introduction to bioremediation, Advantages, limitations and applications Types of Bioremediations: Microbial bioremediation- Natural, Engineered, Ex-situ and in- situ Phytoremediation, Bioaugmentation, Biostimulation, Bioconversion, Bioaccumulation, Bioconcentration, Biomagnification and Biodegradation.

Energy and Biofuels: Non-Conventional or Renewable sources of energy, Energy from Biomass, Biosensors and Biochips, Biofilters, Biofuel Cells.

Unit IV (15L)

Advancement in environmental technology:

Remote sensing and GIS- Principal, terminologies, and objectives. Energy sources for

remote sensing, Types of remote sensing. Applications- Agricultural, Forestry, Water Resource, Urban Planning, Wildlife Ecology, Disaster Assessment. Environmental Impact Assessment: Introduction, Objectives, Classification,Guidelines, Case Study.

Recommended Textbooks and References:

11. Environmental Biotechnology (2005) 2nd edition - Allan Scragg. OUP Oxford publication,
12. Environmental Biotechnology (2010) by Prof. Jogdand, Himalayan publication
13. Environmental Biotechnology, (1987) Foster C.F., John Ware D.A., Ellis Horwood Ltd.
14. Biotechnology and Biodegradation, (1990)Karrely D., Chakrabarty K., Omen G.S., Portfolio Publishing Co Inc.,U.S.,
15. Bioremediation engineering; design and application (1994) John. T. cookson,Jr. Mc Graw Hill, Inc.
16. Environmental Biotechnology (2011) 3rd edition by A.K. Chatterjee, Prentice Hall India Learning Private Limited
17. Environmental Biotechnology (2007) Bimal Bhattachraya and Ritu Banerjee, Oxford university press
18. Environmental pollution control engineering. (2021) 4th edition, C. S. Rao, New age International Publishers.
19. Environmental Biotechnology theory and application (2002) 1st edition, by Gareth Evans and Judith Furlong. John Wiley and Sons Ltd.
20. Environmental Biotechnology Concept and application (2004) 1st edition, edited by Hans-Joachim Jördening and Josef Winter. Wiley VCH Verlag GmbH & Co. KGaA

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IV Semester

Course Title: Lab Course XIV (Based on P-FOB-434 and P-ENB-435)
Course Code: P-LAC-437
Marks 50 **Credit: 02**

Learning Objectives:

- To Provide Hands-on Qualitative and Quantitative analysis of Food Products
- To Provide Hands-on isolation, extraction and characterization of Food Products and production of Silver Nano Particles.
- To undertake a range of practical approaches relevant to sample testing for the presence of pollutants.
- To design experiments for qualitative analysis of water samples.

Course Outcomes:

On the successful completion of the course, the students will be able to –

- develop skills in detection of nutritional value in food
- detect type of spoilage in Food sample.
- determine Acidity, Alkalinity, Salinity, COD, BOD etc.
- estimate Nitrogen of soil (Kjeldals method)and metal content of soil

Practical

1. Isolation and Characterization of food fermenting organism from idli batter.
2. Estimation of ascorbic acid from given food sample by titrimetric method.
3. Analysis of mycotoxin (Aflatoxin) in fungus contaminated food material.
4. Microscopic examination of Food/Milk by breed method.
5. Estimation of lactose from milk.
6. Quality characterization of pasteurized milk by MBRT method.
7. To judge efficiency of pasteurization of milk by Phosphatase test.
8. Detection of microbial count in Milk by SPC method.
9. Isolation and biochemical testing of probiotic cultures (Lactobacilli) from food samples (curd, intestine, sauerkraut, dosa, etc)
10. Check the potential of bacterial culture as probiotic culture by testing bile i) salt tolerance ii) acid tolerance iii) heat tolerance
11. Isolation and detection of nano particles from plant extract (silver nano particles)
12. Spectrophotometric analysis (UV/IR) of nano particles
13. Antimicrobial activity of nano particles
14. Isolation and characterization of heavy metal resistant microbes

15. Plate assays for determination of MIC of heavy metals
16. Bioaccumulation of heavy metals
17. Biosorption of heavy metals
18. Isolation and characterization of microbes degrading xenobiotics
19. Isolation and characterization of microbes degrading PAH
20. Synthesis of nanoparticles using microbes
21. Waste water analysis – pH, COD, BOD, Hardness, halides, Total solids, alkalinity and chloride

Summary of cross cutting issues:

Biotechnology is a collective term for a group of technologies that use biological matter or processes to generate new and useful products and processes. As such, it ranges in complexity and maturity from ancient brewing and bread-making techniques to genetic modification through hybridization and interbreeding of plants and animals, as well as the manipulation of individual genes in humans, animals, plants and micro-organisms. Biotechnology is a key technology for the new millennium. It has an immense range of applications in agriculture, medicine, food processing, environmental protection, mining, and even nanoelectronics.

It is expected to cover some critical issues in the designed curriculum for the development of Students. In our syllabus we tried to include following cross cutting issues.

Cross-cutting issues relevant to Professional Ethics, Gender, Environment and Sustainability, and Human Values into the curriculum:

Sr. No.	Course Name	Code	Relevant to Professional Ethics	Description
1	Genetic Engineering	P-GEE-334	Professional Ethics	Job opportunities in Research Institute and Biotech Industries
2	Microbial Biotechnology	P-MIB-335	Professional Ethics	Students will be absorbed in Fermentation Industries.
3.	Enzyme Technology and Protein Engineering	P-EPE-336	Professional Ethics	Working in Biopharma, food, textile and clinical industries as an employee.
4.	Plant Biotechnology	P-PLB-337	Professional Ethics	job opportunities in Research Institute, Agro Industries and Biotech Industries
5.	Research Methodology and Scientific Report Writing	P-ADD-342	Professional Ethics	students will get an opportunity in research and development pertaining to life sciences
6.	Genomics and Proteomics	P-GEM-432	Professional Ethics	students will get an opportunity in research and development pertaining to life

				sciences with special emphasis of genomic and proteomic research
7.	Pharmaceutical Biotechnology	P-PHB-433	Professional Ethics	Job Opportunities in pharmaceutical and biopharmaceutical
8.	Food and Nano Biotechnology	P-FNB-434	Professional Ethics	Employability in Food Industry, dairy Industry, Fermentation Industry etc

Sr. No.	Course Name	Code	Relevant to	Description
1	Environmental Biotechnology	P-ENB-435	Environment and Sustainability	Students will be able to understand environment problems and solve the issues Work as Consultant and Environment Officer

Curricula developed and implemented have relevance to the local, national, regional and global developmental needs

Sr. No.	Course code	Course Name	Linkage with Local/National/Regional/Global development
1	P-GEE-334	Genetic Engineering	Designing experimental kits, Use the techniques to detect pathogens
2	P-MIB-335	Microbial Biotechnology	Start Up, Production and Recovery of industrial products
3	P-EPE-336	Enzyme Technology and Protein Engineering	Expertise in skills of protein engineering
4	P-PAB-337	Plant Biotechnology	PTC Lab Set UP and Related Research, Bioethics and Biosafety
5	P-SRW-342	Research Methodology and Scientific Report Writing	Expertise in Report, Proposals writing and Presentation
6	P-GEM-432	Genomics and Proteomics	Database Generation
7	P-PHB-433	Pharmaceutical Biotechnology	Start Up (Pharmaceutical)
8	P-FNB-434	Food and Nano Biotechnology	Start Up (Food)
9	P-ENB-435	Environmental Biotechnology	Consultant , Environment Officer

Courses having focus on employability/ entrepreneurship/ skill development

Sr. No.	Name of the Course	Course Code	Activities/Content with a direct bearing on Employability/ Entrepreneurship/ Skill development			Year of introduction
			Employability	**Entrepreneurship**	**Skill development**	
1	Genetic Engineering	P-GEE-334	Study of this course will opens large number of job opportunities in Research Institute and Biotech Industries		Student understand the basics of molecular and cellular biology concepts and techniques.	2018-19
2	Microbial Biotechnology	P-MIB-335	Students will be absorbed in Fermentation Industries.	Student will be able to start Industrial Plant	Students will get idea about upstream and downstream Technology.	2018-19
3	Enzyme Technology and Protein Engineering	P-EPE-336	Working in Biopharma, food, textile and clinical industries as an employee.	Students can establish small scale industry for crude enzyme production, which are in demand for various industries as a one of the raw materials.	Skills related with isolation and purification of enzymes maybe developed	2018-19
4	Plant Biotechnology	P-PLB-337	Job opportunities in Research Institute and Biotech Industries	Set Up PTC Lab	Student understand the basics of Plant biotechnology concepts and techniques	2018-19
5	Research Methodology	P-ADD-	students will get an opportunity in		the students will be	2018-19

	and Scientific Report Writing	342	research and development pertaining to life sciences		updated with the soft skills related to the tools and techniques in Scientific report writing	
6	Genomics and Proteomics	P-GEM-432	students will get an opportunity in research and development pertaining to life sciences with special emphasis of genomic and proteomic research		the students will gain the knowledge on virtual simulations of techniques in molecular biology, protein modelling, drug designing, microarray analysis, protein analysis, genome analysis, genome sequencing and its functioning	2018-19
7	Pharmaceutical Biotechnology	P-PHB-433	Job opportunities in pharmaceutical and biopharmaceutical	Student will be able to start Industrial Plant	Skilled in QA and QC	2018-19
8	Food and Nano Biotechnology	P-FNB-434	This course provide employability in Food Industry, dairy Industry, Fermentation Industry etc	Student can start small scale food Industry and create employability	Students learn the skill of Food processing, food preservation etc.	2018-19
9	Environmental Biotechnology	P-ENB-435	Job opportunities Environment Officer	Knowledge of waste management helps the student to become good Entrepreneur	Student will be skilled in water analysis and soil analysis and waste processing technologies.	2018-19

10	Lab Course XV Dissertation	L-PRW-438			Project work helps the student to develop research aptitude and Laboratory Skills etc.	2018-19