Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Biotechnology

Curriculum

For the Academic Year 2023-24

Under CBCS

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, 2023

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-APB-336	Advance Pharmaceutical Biotechnology	04	40	60	04
P-PAB-337	Plant and Agricultural Biotechnology	04	40	60	04
P-LAC-338	Lab Course IX	04	20	30	02
P-LAC-339	Lab Course X	04	20	30	02
P-LAC-340	Lab Course XI	04	20	30	02
P-LAC-341	Lab Course XII	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

CodeNo.	Title of the course	Hours/ Week	Marks (100)		Credits
			In Sem	End Sem	
P-ENB-432	Environmental Biotechnology	04	40	60	04
P-FNB-433	Food and Nano Biotechnology	04	40	60	04
P-ALB-434	Animal and Livestock Biotechnology	04	40	60	04
P-CBS-435	Clinical Research, IPR, Bioentrepreneurship and Start up	04	40	60	04
P-LAC-436	**Lab Course XIII**	04 +04	20	30	02
P-LAC-437	**Lab Course XIV**	04+04	20	30	02
P-PRW-438	**Lab Course XV Dissertation**	04		100	04
	Total Credits	**36**			**24**

Rajarshi Shahu Mahavidyalaya, Latur
(Autonomous)
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 **(13L)**

DNA isolation and Sequencing methods.

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

Unit-II **(17L)**

Tools of Genetic Engineering

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 cDNA libraries, Joining of DNA Fragments to vectors, Homopolymer tailing, cohesive and blunt end ligation, adaptors, and linkers.

Unit-III **(12L)**

Screening and Selection of Recombinants.

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

Unit-IV **(18L)**

Expression of gene in higher organism

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, and expression in plant 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,

Rajarshi Shahu Mahavidyalaya, Latur
(Autonomous)
M.Sc. Biotechnology
III Semester

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. Nucleic acid Sequencing and its computational analysis.
16. PCR/RFLP technique.

Rajarshi Shahu Mahavidyalaya, Latur
(Autonomous)
M.Sc. Biotechnology
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 Organic Acids, Solvents and Amino Acids

Organic acids: Production of Citric acid; Lactic acid; Acetic acid; Organic feedstock: Butanol; Ethanol, Brewing Industry, Amino acids: Use of amino acids in industry; methods of production; Production of individual amino acids (L-Glutamic acid; L Lysine; L-Tryptophan).

Unit-II: **(14 L)**

Microbial Production of Vitamins, Antibiotics and Recombinant Products

Vitamins-Vitamin B12; Riboflavin; Antibiotics: beta-Lactam antibiotics; amino acid and peptide antibiotics (Streptomycin); Carbohydrate antibiotics; Tetracycline; Nucleoside antibiotics; Aromatic antibiotics. Recombinant Products**:** Production of Hepatitis B Vaccine, Insulin and Erythropoietin.

Unit-III: **(14 L)**

Introduction to the use of microbes in environmental Applications:

Biomethanation, Bioleaching: Mechanism of Bioleaching with example. Biosorption and Microbial recovery of petroleum (MEOR). Microbial polysaccharides: Xanthan and Dextran.

Production of Biopolymers and Bio-pesticides

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

Microbial production of Enzymes:

Immobilization of enzymes, Commercial applications and production of Amylases, Glucose Isomerase, L Asparaginase, Proteases, Pectinases, Lipases. 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. Biology of Industrial Microorganisms (2016) A.L. Demain.
11. Industrial Microbiology (2020) by G. Reed, 4th edition, CBS Publishers (AVI Publishing Co.)
12. Biotechnology, A Textbook of Industrial Microbiology (1990), 2nd edition, Creuger and Creuger, Sinaeur associates inc. U.S.
13. Comprehensive Biotechnology, (1987), Cooney &Humphery. Vol-3. Pergamon press.
14. Text Book of Biotechnology, (2008) 3rd edition, H.K Das, Willey India
15. Industrial Microbiology, (2011), 2nd edition, A.H Patel, Macmillan Publication.

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 quantitation of Antibiotics
6. Production and estimation of lactic acid by Lactobacillus Sp.
7. Production of fermented milk by *Lactobacillus acidophilus.*
8. Comparison of ethanol production using various Organic wastes /raw Material
9. Laboratory scale production of biofertilizers
10. Amylase production by bacteria
11. Amylase production by fungi

(Autonomous)
M.Sc. Biotechnology
III Semester

Course Title: Advanced Pharmaceutical Biotechnology

Course Code: P-APB-336
Marks: 100 Lectures :60 Credit:04

Learning Objectives:

- To understand different antibacterial, antifungal and antiviral drugs and their mode of action.
- To understand mechanism of action of chemotherapeutic agents
- To understand drug discovery and development
- To understand regulatory guidelines in pharmaceutical industry

Course Outcomes:

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

- Students will have the knowledge of different antibacterial, antifungal and antiviral drugs, their mode of action and also the type and medicinal applications of secondary metabolites.
- Students will able to understand the use of chemotherapeutic agents in the treatment of cancer
- Students will come to know the detailed procedure of drug discovery.
- They would be able to understand the regulatory guidelines and also the standards of drugs set by national and international pharmacopoeia

UNIT -I: (15L)

Chemotherapeutic Agents and Antibiotics

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 Secondary Metabolites: Types and Medicinal Applications

UNIT-II: (15 L)

Antibacterial, Antifungal and Antiviral Drugs

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)

Drug Discovery, Development and Targeting

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: (15L)

Clinical Trials, Regulatory Guidelines and Pharmacopoeia

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 teratogenicity and mutagenicity. Biosimilar Technology, Introduction to Indian, International Pharmacopoeia and global regulatory guidelines.

Recommended Textbooks & 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. 22
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. Purohit, Saluja- Pharmaceutical Biotechnology-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

(Autonomous)
M.Sc. Biotechnology
III Semester

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

Course Objectives:

- To study antibacterial activity of commercially available drugs
- To study different quantitative tests for pharmaceutical products
- To study effect of disinfectant on bacterial growth.
- To study global regulatory guidelines in pharma industry.

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

- understand, how to avoid spoilage of pharmaceutical products.
- calculate minimum inhibitory concentrations of different antibacterial drugs.
- carry out sterility testing of commercial pharmaceuticals.
- determine of shelf life of antibiotics.

Practicals:

1. Estimation of penicillin/streptomycin by biological assay.
2. Estimation of penicillin/streptomycin by chemical assay.
3. Assay of antimicrobial activity of Penicillin, Chloramphenicol, streptomycin
4. Determination of Minimum Inhibitory Concentration (MIC) of Antibiotic
5. Determination of shelf life of antibiotics (Expired drugs)
6. Sterility testing of commercial pharmaceuticals.
7. Study of microbial spoilage of pharmaceuticals.
8. Sterility testing of injectable as per IP.
9. Effect of chemical disinfectant on growth of bacteria
10. Study of Pharmacopeia and global regulatory guidelines in pharma industry
11. Visit to Pharmaceutical industry

III Semester

Course Title: Plant and Agricultural Biotechnology
Course Code: P-PAB-337
Marks: 100 Lectures: 60 Credit:04

Learning Objectives:

- To understand the advancements in the field of biotechnology with respect to plants.
- To follow modern techniques and their applications in crop improvements, such as tissue culture, plant breeding, and transgenics.
- To understand the modern trends in plant & agricultural biotechnology.
- To understand pathological aspects of plant disease.

Course Outcomes:

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

- describe concepts and techniques in plant biotechnology.
- discuss principles of plant breeding.
- explain applications of agricultural biotechnology in modern agriculture.
- demonstrate the practices of sustainable agriculture.

UNIT-I (10 L)

Plant Resource Development

Domestication and introduction of plants, Origin of cultivated plants, Vavilov's centres of origin. Plants as sources for food, fodder, fibres, spices, beverages, edible oils, drugs, narcotics, insecticides, timber, gums, resins, and dyes; latex, cellulose, starch, and its products; Energy plantations; Botanical Gardens and Herbaria.

UNIT-II (16 L)

Plant Pathology

Important crop diseases caused by viruses, bacteria, mycoplasma, fungi, and nematodes; Modes of infection and dissemination; Molecular basis of infection and disease resistance/ defense; Physiology of parasitism and control measures. Fungal toxins. Modelling and disease forecasting; Plant quarantine.

UNIT-III (16 L)

Plant Biotechnology

Development of male and female gametophytes, pollination, and fertilization; Endosperm— its development and function. Patterns of embryo development; Polyembryony, apomixis; Pollen haploids, embryo rescue methods and their applications. Totipotency, polarity, symmetry and differentiation; Cell, tissue, organ culture. Protoplast culture. Somatic hybrids and Cybrids; Micropropagation; Somaclonal variation and its applications.

UNIT-IV (18 L)

Agricultural Biotechnology

Methods of plant breeding— introduction, selection and hybridization (pedigree, backcross, mass selection, bulk method); Mutation, polyploidy, male sterility, and heterosis breeding.

Use of apomixis in plant breeding; DNA sequencing; Genetic engineering—methods of transfer of genes; Transgenic crops and biosafety aspects; Development and use of molecular markers in plant breeding; Tools and techniques—probe, southern blotting, DNA fingerprinting, PCR and FISH.

Recommended Textbooks & References:

1. Biotechnology and Genomics. Gupta P.K. (2004) - Rastogi Publications, Meerut, India.
2. Transgenic Plants: A Production System for 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, Germany
5. Textbook of Modern Plant Pathology, (1994) Bilgrami K.S and Dube H.G. - Vikas Publications, New Delhi.
6. Genetics and Biotechnology in Crop Improvement (1998) -Gupta P.K. Rastogi Publications, Meerut.
7. Fundamentals of Plant Pathology, (1996) Pathak V.N, Khatri N.K., Pathak M. - Agrobotanical Publications, Bikaner.
8. General Microbiology, (1990) Vol. II, Powar C.B., Daginawala H.F., - Himalaya Publishing House, Mumbai.
9. Agricultural Biotechnology, (2002) Purohit S.S.- Agrobios India, Jodhpur.
10. Biotechnology, Satyanarayana U. (2007) - Books and Allied Pvt. Ltd.Kolkata.
11. Biofertilizer and Organic Farming, (1998) Vyas S.C., Vyas S., Vyas S., and Modi H.A. - Akta Prakashan, Nadiad, G.S, Meerut.
12. Experiments in Microbiology, Plant Pathology, Tissue culture and Mushroom cultivation, (1998) Vyas S.C.,Vyas S., Vyas S.,and Modi H.A - Vishwa Prakashan, New age international (p) Ltd., New Delhi.
13. Microbiology and Biotechnology: A Laboratory Manual, (2004), Kalaichelvan P.T. and Dandiya P.C, MJP Publishers, Chennai.
14. Laboratory manual of Plant Biotechnology, (1995), Purohit S.S. A . Aneja K.R. - Agrobotonical Pub.India.
15. Methods in Biotechnology, (1997) Schmauder Hans Peter - Taylor and Francis, London.
16. Methods in Plant Molecular Biology. (1989) 1st edition, Schuler M. A. and Zielinski , Academic press, R. E.
17. Methods in Biotechnology and Bioengineering, Vyas S.P. and Kohli D.V. (2002) - CBS Publishers and Distributors, New Delhi.

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. Isolation of bacterial plant pathogens
7. Isolation of fungal plant pathogens
8. Effect of media on plant growth
9. Plant breeding experiments.
10. Visit botanical gardens.
11. Plant DNA isolation
12. Protoplast isolation
13. Synthetic seed preparation
14. Identification of bacterial diseases.
15. Identification of fungal diseases.
16. Identification of viral diseases.
17. Embryo culture
18. RAPD

Skill Enhancement Course

Course Title: Research Methodology and Scientific Report Writing
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 them with 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. (5 L)

Basic Concepts, Types & Methods of Research

What is Research? Objectives of Research; Scientific Research; Importance of research methodology 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; Sampling Techniques 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-t test); 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 analysis and 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 patent law.

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 Age International 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 Millan Publishing Co., Inc.
7. Fundamental of Research Methodology and Statistics (2006). Singh, Y. K. New Delhi. New International (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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(Autonomous)
M.Sc. Biotechnology
IV Semester

Course Title: Environmental Biotechnology **Course Code: P-ENB-432**
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 **(17 L)**

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 **(16L)**

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.

Unit III **(14 L)**

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- Types Energy & Biofuels: Non-conventional or renewable sources of energy, Energy from Biomass. Biofuel cells.

Unit IV **(13 L)**

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

Rajarshi Shahu Mahavidyalaya, Latur
(Autonomous)
M.Sc. Biotechnology
IV Semester

Course Title: Food and Nano Biotechnology **Course Code: P-FNB-433**
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 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:

Biotechnology for Food Ingredients (16L)

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: (14L)

Food Applications and Functional Foods

Solid State Fermentations for food applications, Genetic Engineering of baker's yeast, Biotechnology of wine yeast, Genetic Modification of Plant Oils for Food uses, Biotechnology of -carotene from Dunaliella, SCP: Spirulina and Chlorella, Biotechnological approaches to improve nutritional quality and shelf life of fruits and vegetables.

Unit-III: (16L)

Food Safety, Traditional Fermentations 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, Biotransformation applicable to food industries, Fermentation technology for traditional food of the Indian subcontinent, 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 (2005) 2nd edition, CRC Taylor & Francis Kalidas Shetty G.Paliyath, A Pometto R,E. Levin
2. Food Microbiology, (2006) 2nd edition, Adam M.R and Moss M.O -New Age International Pub.
3. Food Microbiology, (2013) Frazier W.C and Westhoff D.C - 4th Edi., Tata McGraw Hill
4. Food Processing and Preservation, (2002) 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, Jay J.M. (1992) - 4th Ed. Chapman and Hall,New York ,NY, USA.
8. Bio-Nano technology concept and applications (2013) Madhuri Sheron, Sunil Pande- Ane Books New Delhi
9. Nanotechnology (2002) 1st edition, Pearson Mark Ratner, Daniel Ratner
10. Nanotechnology an Introduction (2012) 1st edition, Ramsden-Elsevier

IV Semester

Course Title: Lab Course XIII **Course Code: P-LAC-436**
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 student will be able to-

- develop skills for qualitative and quantitative analysis of food products.
- characterize nanoparticles
- determine Acidity, Alkalinity, Salinity, DO, BOD, etc.
- detect pathogens from various polluted ecological regions.

Practicals

1. Isolation and Characterization of food fermenting organisms from idli batter
2. Estimation of ascorbic acid from given food sample by the 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. 1Spectrophotometric 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. Isolation of microorganisms from polluted soil.
22. Isolation of microorganisms from polluted water.
23. Isolation of microorganisms from polluted air.
24. Determination of DO
25. Determination of BOD
26. Determination of hardness of water
27. Determination of total solids.
28. Determination of alkalinity.

IV Semester

Course Title: Animal and Livestock Biotechnology **Course Code: P-ALB-434**
Marks: 100 **Lectures: 60** **Credit: 04**

Learning Objectives:

- To conduct basic and applied research in the area of animal biotechnology.
- To analyze and characterize Genome of indigenous livestock breeds
- To Develop affordable new generation vaccines and diagnostics against major diseases of livestock, dogs, and poultry.
- To train quality human resource and help in the development infrastructure in animal biotechnology

Course Outcomes:

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

- know basics of animal cell culture.
- know about advanced trends in animal biotechnology.
- know the molecular methods in livestock biotechnology.
- know about new trends in animal breeding and transgenic technology.

Unit I: **[15 L]**

Basics of Animal cell culture, culture media and cell culture types.

Introduction, importance, history of animal cell culture , Planning and Layout of animal tissue culture laboratory, Different type of cell culture media, growth supplements, serum free media, balanced salt solution, other cell culture reagents, Different tissue culture techniques including primary and secondary culture, continuous cell lines, suspension culture, culture of different tissues and its applications, organ culture etc., Behaviour of cells in culture conditions, their growth pattern, cell metabolism, estimation of cell number, Development of cell lines, characterization and maintenance of cell lines, cryopreservation, common cell culture contaminants.

Unit II: **[15 L]**

Scale up Technique and commercial applications of animal biotechnology

Cell culture reactors; Scale-up in suspension; Scale and complexity; Mixing and aeration; Rotating chambers; Perfused suspension cultures; Fluidized bed reactors for suspension culture; Scale-up in monolayers, Growth monitoring, Transfection and transformation of cells; Commercial scale production of animal cells, Application of animal cell culture for in vitro testing of drugs; Testing of toxicity of environmental pollutants in cell culture; Application of cell culture technology in production of human and animal viral vaccines and pharmaceutical proteins.

Unit III: **[15 L]**

Molecular methods in Livestock biotechnology

Genome organization of any suitable Livestock with example – physical and genetic map, current status of genome maps of livestock, Marker Assisted Selection (MAS), Polymerase Chain Reaction (PCR), its types and applications; Molecular markers and its applications - RFLP, RAPD, AFLP, Microsatellite/ Minisatellite markers, SNP marker. DNA

fingerprinting. DNA sequencing, Genome sequencing, Genomic Library, Genomics database of Livestock.

Unit IV: [15 L]

Animal breeding and Transgenic technology

History of development of important breeds of dairy cattle, Methods of cross breeding and its types, milk quality and production efficiency, Transgenesis and methods of gene transfer in animals, Statistical techniques for analyzing molecular genetic data, Quantitative Trait Loci (QTL) mapping and its application in animal breeding, Genome scan, Candidate gene approach, Genomic selection in livestock, applications of transgenic technology in livestock improvement and molecular bio pharming.

Recommended Textbooks and References:

1. Culture of Animal Cells, (2005) 5th Edition, Wiley-Liss, Freshney
2. Animal Cell Culture - Practical Approach, (2000) 3rd Edition, Oxford University Press, Ed. John R.W. Masters
3. Animal Cell Culture Techniques, (1998) Ed. Martin Clynes, Springer.
4. Animal breeding biotechnology (2017) by Thompson, KOROS PRESS.
5. Genetic Improvement of Livestock and Poultry (2013) by C.V. Singh (Author), R.S. Barwhal (Author) New India Publishing Agency
6. An Introduction to Quantitative Genetics. (1996) Falconer DS & Mackay TFC.
7. Statistical Techniques in Quantitative Genetics. (1996) Tata McGraw-Hill. Tomar SS.

Course Title: Clinical Research, IPR, Bio-entrepreneurship and Start Up
Course Code: P-CBS-435
Marks: 100 **Lectures: 60** **Credit:04**

Learning Objectives:

- To develop experts or skilled professionals to handle large clinical data procedure with correct guidelines
- To acquire a basic understanding of the concepts and practices of clinical trials in pharmaceutical industry.
- To enable Students to understand issues surrounding the risks and benefits of drugs.
- To encourage the student for startup development.

Course Outcomes:

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

- know the new drug development process.
- understand the regulatory and ethical requirements in clinical research.
- conduct the clinical trials of nascent drugs.
- know safety monitoring and reporting in clinical trials.

Unit I: **(17 L)**

Introduction to Clinical Research

Introduction to Drug Discovery and drug Development, Introduction to Clinical Research Industry, Types of Clinical research, Phases of clinical research, drug development process, manufacturing of drugs and Good Manufacturing Practices (GMP), Toxicology: Mutagenicity, teratogenicity and carcinogenicity, Systemic toxicology (Single dose and repeat dose toxicity studies)

Unit II: **(17 L)**

IPR

Basic concepts of Intellectual Property rights, Evolution of ethics in clinical research, Ethics and Ethical Guidelines for Clinical Trials and Good Clinical Practice (GCP), Human rights in clinical research, Principles of Good Laboratory Practices, Good Manufacturing Practices & Good Clinical Practices. Types of clinical trials, single blinding, double blinding, open access, randomized trials and their examples preclinical studies, Concepts and Application in clinical trials, Quality Assurance and Quality Control in Clinical Trials

Unit III: **(13 L)**

General Pharmacology

Introduction, definitions and scope of pharmacology, Routes of administration of drugs, New drug discovery process, New Drug Application and Approval. Pharmacokinetics (absorption, distribution, metabolism and excretion), Pharmacodynamics, stages of pharmacodynamics.

Unit IV: **(13 L)**

Bio-entrepreneurship

Concept of Bio-entrepreneurship, Scope for biotech students. Concept of Bio-entrepreneurship, Importance, Steps of Bio-entrepreneurship development Data Management in clinical Research, Safety monitoring in clinical trials. Clinical Trial Start up activities: Site Feasibility Studies, Pre-study visit, Site initiation visit.

Recommended Textbooks and References:

1. Handbook of clinical research. (1994) Julia Lloyd and Ann Raven Churchill Livingstone c. publications.
2. Principles of Clinical Research (2018) by Giovanna di Ignazio, Di Giovanna and Haynes CRC Press / BSP Books
3. Basic and Clinical Pharmacology, (2021) Prentice Hall, International, Katzung, B.G.
4. Textbook of Clinical Trials (2005) edited by David Machin, Simon Day and Sylvan Green, March, John Wiley, and Sons.
5. Basic principles of clinical research and methodology, (2007) 1st edition, by S. K. Gupta, JPB publication.
6. Handbook of good clinical research practice (2005) by World Health Organization.
7. Fundamentals of clinical trials (2015) 5th edition by Lawrence M. Friedman, Curt D. Furberg, David L. DeMets, Christopher B. Granger.
8. Designing Clinical Research (2013) 4th edition by Dr. Stephen B Hulley, MD, MPH, Steven R Cummings, MD, Warren S Browner, MD
9. An Insider's Guide To Clinical Trials (2011) by Curtis L. Meinert

Rajarshi Shahu Mahavidyalaya, Latur
(Autonomous)
M.Sc. Biotechnology
IV Semester

Course Title: Lab course XIV **Course Code:P-LAC-437**

Marks: 50 **Credit: 02**

Learning objectives:

- To learn basic tools and techniques in animal cell culture.
- To know quality and to measure quantity of cells in cell lines.
- To study preservation and maintenance of cell lines.
- To know about genomic databases of livestock and application of molecular markers in livestock research.

Course Outcomes:

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

- handle and maintain cell lines.
- check quality of cell lines and quantify the cells in cultured cells.
- apply molecular markers in study of livestock breeds.
- preserve and maintain animal cell lines.

Practicals:

1. Packing and sterilization of glass and plastic wares for cell culture.
2. Preparation of reagents and media for cell culture
3. Primary culture technique for chicken embryo fibroblast
4. Secondary culture of chicken embryo fibroblast
5. Cultivation of continuous cell lines
6. Quantification of cells by trepan blue exclusion dye
7. Isolation of lymphocytes and cultivation of lymphocytes
8. Study of effect of toxic chemicals on cultured mammalian cells
9. Study of effect of virus on mammalian cells
10. Suspension culture technique
11. Cryopreservation of cell primary cultures and cell lines
12. Practical based on genomic databases of livestock and its analysis
13. A study of molecular markers by using RFLP and AFLP
14. To study different Techniques of specimen collection
15. Commonly used instruments in experimental pharmacology
16. Study of laboratory animals
17. Types of preclinical experiments
18. Techniques of blood collection from animals

19. Standard operating protocols in clinical research/trails
20. Study of different routes of drugs administration
21. Visit to Biotechnology industry/ Research Institute.

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	Advance Pharmaceutical Biotechnology	P-APB-336	Professional Ethics	Job Opportunities in pharmaceutical and biopharmaceutical
4	Plant and Agriculture 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	Food and Nano Biotechnology	P-FNB-433	Professional Ethics	Employability in Food Industry, dairy Industry, Fermentation Industry etc
7	Animal and Livestock Biotechnology	P-ALB-434	Professional Ethics	Employability in Animal cell culture laboratory
8	Clinical Research, IPR, Bio-entrepreneurship and Start Up	P-CBS-435	Professional Ethics	job opportunities in clinical Research and Biotech Industries

Sr. No.	Course Name	Code	Relevant to	Description
1	Environmental Biotechnology	P-ENB-432	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-APB-336	Advance Pharmaceutical Biotechnology	Start Up (Pharmaceutical)
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-ENB-432	Environmental Biotechnology	Consultant , Environment Officer
7	P-FNB-433	Food and Nano Biotechnology	Start Up (Food)
8	P-ALB-434	Animal and Livestock Biotechnology	Start up Animal tissue culture lab
9	P-CBS-435	Clinical Research, IPR, Bio-entrepreneurship and Start Up	Start Up (lab)

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	Advanced Pharmaceutical Biotechnology	P-APB-336	Job opportunities in pharmaceutical and biopharmaceutical	Student will be able to start Industrial Plant	Skilled in QA and QC	2018-19
4	Plant and Agriculture Biotechnology	P-PAB-337	Job opportunities in Research Institute, Agro and Biotech Industries	Set Up PTC Lab	Student understand the basics of Plant biotechnology concepts and techniques	2023-24
5	Research Methodology and Scientific Report Writing	P-ADD-342	students will get an opportunity in research and development		the students will be updated with the soft skills related to the tools and techniques in	2018-19

			pertaining to life sciences		Scientific report writing	
6	Environmental Biotechnology	P-ENB-432	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
7	Food and Nano Biotechnology	P-FNB-433	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
8	Animal and Livestock Biotechnology	P-ALB-434	Job opportunities in Animal cell culture labs		Students will able to differentiate different breeds through molecular techniques.	2023-24
9	Clinical Research, IPR, Bio-entrepreneurship and Start Up	P-CBS-435	Job opportunities in Clinical research laboratories.	Student will be able to start Clinical research lab.	Student will understand the basics of Clinical research concepts and techniques.	2023-24
10	Lab Course XV Dissertation	L-PRW-438			Project work helps the student to develop research aptitude and Laboratory Skills etc.	2018-19