# Rajarshi Shahu Mahavidyalaya (Autonomous), Latur

## Biotechnology

## CHOICE BASED CREDIT SYSTEM (CBCS)

## SEMESTER PATTERN

## (w.e.f. Academic Year 2019-20)

## SYLLABUS FOR

## M.Sc. II Year (Biotechnology)

**Revised in JUNE 2020**

# Rajarshi Shahu Mahavidyalaya (Autonomous), Latur

# Biotechnology

**1. Introduction:**

Biotechnology is technology based on biology - biotechnology harnesses cellular and biomolecular processes to develop technologies and products that help to improve our lives and health of our planet. Taking into consideration of the importance of Biotechnology Rajarshi Shahu Mahavidyalaya, Latur, have taken an initiative to introduce a new emerging field as a post graduate Programme in biotechnology under the faculty of science. M.Sc. Biotechnology is a Two year post graduate degree program which is started in the academic year 2005-06.

The syllabus was designed according to employability in the field of biotechnology. After designing syllabus, we have taken online feedback on curriculum from the academia and Industry expert. The feedback is analyzed, recommendation is reviewed and necessary changes are made in the syllabus by members of BOS. The board of studies in biotechnology follows the systematic process in design and development of the curriculum. In the design and development of curriculum, the regulation and guidelines of curriculum frame work stipulated by apex bodies such as Parent University and UGC. Faculty members of the department actively participated in syllabus designing, workshop, seminars and conferences. The programme outcome is given in the curriculum display in college website so that students can look for it before taking admission. The learning objectives and course outcome of course are given in the syllabus of respective course and communicated to students on the beginning of course.

**2. Title of the Programme:** **M.Sc. Biotechnology**

**3. Learning Objectives of the Programme:**

The main objective is to create biologically and technologically skilled minds for the understanding theoretical and practical knowledge essential for implementation from LAB to LAND further it will useful to find the solutions of various interacting biological phenomenon. It helps effectively to inculcate scientific temper and social attitude to solve various problems in the field of science.

The member of Board of Studies from various organizations of repute have a strong recommendation for Job oriented syllabus is to be included. Accordingly, the necessary changes has been effectively implemented in Curriculum.

**4. Programme Specific outcomes/ Programme Outcomes:**

At the end of the program the student will be able to

- Students should be able to integrate basic principles of common analytical techniques of protein molecular structures to engage in hands-on practices for implementation of such techniques to facilitate the development of biopharmaceutical manufacturing
- Students should be able to integrate basic principles of protein chemistry and molecular interactions to engage in hands-on practices to facilitate the development and manufacturing of biopharmaceutical formulations suitable for use as human therapeutics
- Students should be able to integrate basic principles of process units operations of recombinant protein production in hands-on practices for implementation of such techniques to facilitate the development of biopharmaceutical manufacturing
- Students should be able to integrate fundamental concepts of leadership, entrepreneurship and innovation, financial decision making and marketing to business enterprises.
- Students should be able to integrate their didactic and practical knowledge of molecular biotechnology, protein expression, and structural biology to the development of new protein drugs.
- Plan, conduct and write-up a programme of original research Practical skills – able to:
- Plan and execute safely a series of experiments;
- Use laboratory methods to generate data;
- Analyze experimental results and determine their strength and validity; • Prepare technical reports;
- Give technical presentations;
- Use the scientific literature effectively;
- Use computational tools and packages. Transferable skills – able to:
- Communicate effectively through oral presentations, computer processing and presentations, and written reports;
- Work independently and as part of a team
- Integrate and evaluate information from a variety of sources;
- Use Information and Communications Technology;
- Manage resources and time;
- Learn independently with open-mindedness and critical enquiry;
- Learn effectively for the purpose of continuing professional development.

**5. Local, Regional and Global relevance of Syllabus:**

Curriculum developed and implemented have relevance to the local, regional and global developmental needs which is reflected in Programme Specific Outcomes/ Programme Outcomes and Course Outcomes of the Programmes offered by the College.

Global and local focus has slowly shifted to using knowledge of life Science for innovative technology development that is being used for betterment of human life. Many fundamental and advanced research fields comes under the umbrella of Biotechnology e.g. Genetic Engineering, Plant Biotechnology and Genomics and Proteomics etc.

| | |
|---|---|
| **6. Duration of the Course:** | **Two years** |
| **7. Eligibility of the Course:** | **B.Sc. science** |
| **8. Strength of the Students:** | **60** |
| **9. Fees for Course:** | **As per University/College rules.** |
| **10. Admission / Selection procedure:** | **Admission by merit through Registration** |
| **11. Teacher's qualifications:** | As per UGC/University/College rules |
| **12. Standard of Passing:** | As per UGC/University/College rules |
| **13. Nature of question paper with scheme of marking:** | As per UGC/University/College rules |
| **14. List of book recommended:** | Included in syllabus |

**15. Laboratory Equipment's, Instruments, and Measurements etc.:**

The department of biotechnology has well equipped laboratories with all necessary and advance instrumentation facility.

| | |
|---|---|
| **16. Rules and regulations and ordinance if any:** | As per UGC/University/College rules |
| **17. Course duration:** | Each theory course is of 60 Contact hours |
| **18. Medium of the language:** | English |

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

**Department of Biotechnology**

**Choice Based Credit System**

**Course Structure of M. Sc. Biotechnology Second Year (w.e.f. June 2018)**

## 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- IX** | 04 | 40 | 60 | 04 |
| P-MIB-335 | **Microbial Biotechnology-X** | 04 | 40 | 60 | 04 |
| P-EPE-336 | **Enzyme Technology and Protein Engineering-XI** | 04 | 40 | 60 | 04 |
| P-PLB-337 | **Plant Biotechnology-XII** | 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** | 04 | 20 | 30 | 02 |
| | **Total Credits** | | | | 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-XIII** | 04 | 40 | 60 | 04 |
| P-PHB-433 | **Pharmaceutical Biotechnology-XIV** | 04 | 40 | 60 | 04 |
| P-FOB-434 | **Food and Nano Biotechnology -XV** | 04 | 40 | 60 | 04 |
| P-ENB-435 | **Environmental Biotechnology - XVI** | 04 | 40 | 60 | 04 |
| P-LAC-436 | **Lab Course XIII** | 04 | 20 | 30 | 02 |
| P-LAC-437 | **Lab Course XIV** | 04 | 20 | 30 | 02 |
| P-PRW-438 | **Lab Course XV**<br>**Dissertation** | 04 | - | 100 | 04 |
| | Total Credits | | | | 24 |

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

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

**Learning Objectives:**

- To illustrate creative use of modern tools and techniques for manipulation and analysis of genomic sequences.
- To expose students to application of recombinant DNA technology in biotechnological research.
- To train students in strategizing research methodologies employing genetic engineering techniques.
- Gain an understanding of basic molecular and cellular biology concepts and techniques.
- Gain an understanding of current experimentation in biotechnology and genetic engineering.
- To understand Genetic testing and genetic therapies.
- Control of gene expression and the process of development in eukaryotes.

**Course Outcomes:**

- Technical know-how on versatile techniques in genetic engineering like PCR, Blotting, molecular diagnosis, cell profiling etc.
- An understanding on application of genetic engineering techniques in basic and applied experimental biology.
- Proficiency in designing and conducting experiments involving genetic manipulation.
- Understand the concept of recombinant DNA technology or genetic engineering.
- 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 to vectors, Homo polymer tailing, cohesive and blunt end ligation, adaptors, linkers.

**Unit-III:** **(14 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:** **(16 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.

**Text & References:**

1. Principles of Gene manipulation (1994) Old R.N. and Primrose S.B.
2. From Genes to Clones (1987) Winnaeker E.L.
3. Recombinant DNA (1992) Watson J.D., Witreowski J., Gilman M. And Zooller M.
4. An Introduction to GeNETIC Engineering: Nicholl, D.S.T.
5. Molecular Biotechnology (1996) Pasternak

6. The Biochemistry of Nucleic acid (1996) Adam et al
7. Genetic Engineering (1998) Janke k. swtlow

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

**Course Title: Lab Course IX** **Course Code: P-LAC-338**
**Marks: 50** **Credit: 02**

**Learning Objectives:**

- To illustrate creative use of modern tools and techniques for manipulation and analysis of genomic sequences.
- To expose students to application of recombinant DNA technology in biotechnological research.
- To train students in strategizing research methodologies employing genetic engineering techniques.
- Gain an understanding of basic molecular and cellular biology concepts and techniques.
- Gain an understanding of current experimentation in biotechnology and genetic engineering.
- To understand Genetic testing and genetic therapies.
- Control of gene expression and the process of development in eukaryotes.

**Course Outcomes:**

- Technical know-how on versatile techniques in genetic engineering like PCR, Blotting, molecular diagnosis, cell profiling etc.
- An understanding on application of genetic engineering techniques in basic and applied experimental biology.
- Proficiency in designing and conducting experiments involving genetic manipulation.
- Understand the concept of recombinant DNA technology or genetic engineering

**Practicals:**

1. Isolation of nuclei and analysis of chromatin- i) determination ofmononucleosomal size ii) chromatin gel electrophoresis
2. Endonuclease digestion of nuclei and analysis of DNA fragments by agarose gelelectrophoresis
3. Thermal melting of DNA

4. Isolation of plasmid DNA-i) minipreparation 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.

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

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

**Learning Objectives:**

- The objective of the course is to create general understanding amongst the students in the subject of Microbial Technology through in-depth lectures & laboratory practicals.
- The objective of the course is to understand them a general overview, concepts and basic principles in the subject of Microbial Technology with emphasis on Upstream and Downstream process.

**Course Outcome:**

- Understand the various concepts of fermentation; know the differences between aerobic and anaerobic fermentation
- Understand the growth of microorganism and their role in producing foods and drinks.
- (skills) isolate and identify microorganisms from fermenting fruits, cereals and milk;
- Produce some drinks and foods e.g., bread, beer, wine and vinegar resulting from alcoholic fermentation; produce some foods and drinks e.g., cheese, butter, yoghurt resulting from acidic
- Fermentation; and design a simple containment system (Bioreactor / fermenter)
- The course concept of microbial growth, metabolism and applications of microbial technology in varied fields. The theory course structure will be complimented by practical sessions. This course will provide a strong understanding of applied microbiology and will help the students to explore work opportunities in Biotechnology Companies and Industries as well.

**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 and Antibiotics**

Vitamins-Vitamin B12; Riboflavin; Antibiotics: beta-Lactam antibiotics; amino acid and peptide antibiotics (Streptomycin); Carbohydrate antibiotics; Tetracycline; Nucleoside antibiotics; Aromatic antibiotics

Production of Hepatitis B Vaccine, Insulin and erythropoietin by recombinant technology.

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

**Introduction to the use of microbes in environmental Applications**

Bio methanation, Bioleaching: Mechanism of Bioleaching with example. Biosorption and Microbial recovery of petroleum (MEOR)

Production of microbial polysaccharides: Xanthan and Dextran

Production of Biopolymers and Biopesticides

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

**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.

**Text & References:**


1. Biotechnoloogy, (A text book of industrial Microbiology),Panima Publishers, New Delhi, 2ndedition, 2003 Wulf Cruger and Anneliese Cruger.
2. Industrial Microbiology, Willey Eastern Ltd, New Delhi,1stEdi tion, 2006 Casida, J.R., L.E.
3. Industrial Microbiology, CBS Publishers, New Delhi, 4th Edition, 1987 Prescott and Dunn
4. Principles of Fermentation Technology, 2nd Edition,Pergamon Press, Oxford, 2005 Stanbury, P.F., and Whitaker, A.
5. Modern Industrial Microbiology and Biotechnology, 1st Edition., 2001 Nduka Okafar.
6. Biotechnology. Uppala Author Publisher Interlinks,Vijaywada, India. Satyanarayana U. (2005)
7. Microbial technology peppler & perlman. Vol- I, II Academic Press

8. Basic Biotechnology. Academic Press Inc Ltd, London. Bu'Lock J. and Kristansen B. (Eds) (1987)
9. Manual of Industrial Microbiology and Biotechnology. 2nd Edition, ASM, Washington, USA. Demain A.L., Davies J.E. (Ed in Chief) (1999)
10. Biology of Industrial Microorganisms by A.L. Demain.
11. Industrial Microbiology by G. Reed (Ed), CBS Publishers (AVI Publishing Co.)
12. Biotechnology, A textbook of industrial Microbiology by Creuger and Creuger, Sinaeur associates.
13. Manual of industrial Microbiology and Biotechnology 2nd edition by Davis J.E. Demain A.L. ASM publications.
14. Comprehensive biotechnology Cooney &Humphery. Vol-3. Pergamon press.
15. Text book of biotechnology H.K Das 3rd ed. Willey India
16. Industrial microbiology A.H Patel Macmillan Publication.

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

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

**Learning Objectives:**

- The objective of the course is to create general understanding amongst the students in the subject of Microbial Technology through in-depth lectures & laboratory practicals.
- The objective of the course is to understand them a general overview, concepts and basic principles in the subject of Microbial Technology with emphasis on Upstream and Downstream process.

**Course Outcome:**

- Understand the various concepts of fermentation; know the differences between aerobic and anaerobic fermentation
- Isolate and identify microorganisms from fermenting fruits, cereals and milk;
- Produce some drinks and foods e.g., bread, beer, wine and vinegar resulting from alcoholic fermentation; produce some foods and drinks e.g., cheese, butter, yoghurt resulting from acidic
- Fermentation; and design a simple containment system (Bioreactor / fermenter)

**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

**Rajarshi Shahu Mahavidyalaya (Autonomous), Latur**
**M.Sc. Biotechnology (Semester Pattern)**
**III Semester**
**Course Title: Enzyme Technology and Protein Engineering**
**Course Code: P-EPE-336**
**Marks: 100 Lectures: 60 Credit: 04**

**Learning Objective:**

- 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.
- It also deals with current applications and future potential of enzymes.

**Course Outcome:**

- The student will be able to describe structure, functions and the mechanisms of action of enzymes.
- The student will learn kinetics of enzyme catalyzed reactions and enzyme inhibitory and regulatory 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.

**Unit-I: (5 L)**

**Introduction to enzymes & enzyme kinetics**

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

**Unit–II: (22 L)**

**Enzyme kinetics**

Enzyme kinetics, Michaelis - Menten equation, Brigg's-Haldane equation, Graphical procedures in enzymology - advantages and disadvantages of alternate 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:** **(13 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:** **(20 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)

**Text & References:**


1. Bailey JE, Ollis, DF: Biochemical Engineering Fundamentals
2. Blanch HW and Clark DS: Biochemical Engineering Marcel Decker
3. Schugerl K., Bellgart KH (Eds): Biorection Engineering, modeling and control: Springer-Verlag, Berlin.
4. Enzymes by palmer,
5. Wiseman, A: Handbook of Enzyme Biotechnlogy, 3rd Edition, Ellis Horwood Publication
6. Moser, A: Bioprocess technology, kinetics and reactors: Springer Verlag
7. Biochemical Engineering Principles and functions by SyedTrnveer Ahmed Inamdar, PHI Learning Private limited.

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

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

**Learning Objective:**

- 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.
- Also, it deals with current applications and future potential of enzymes.

**Course Outcome:**

- The student will learn kinetics of enzyme catalyzed reactions and enzyme inhibitory and regulatory 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.

**Practicals:**

1. Isolation of high yielding microbial strains for the production of commercially 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 genetic manipulation methods.
11. Development of enzyme assay methods.
12. Formulation of enzyme stability.

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

**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.

**Course Outcome:**

- Concepts, principles and process es in plant biotechnology.
- Applications. Presentation of ongoing research.
- The ability of explanation of concepts, principles and usage of the acquired knowledge in biotechnological, pharmaceutical, medical and agricultural applications.
- Transmissible skills. Critic usage of literature and other sources, collection and interpretation of data, scientific and technical terminology.

**Unit-I:** **(12 L)**

**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

Micropropagation

**Unit-II:** **(18 L)**

**Plant Tissue Culture-II**

Protoplast culture

Embryo culture and embryo rescue

Anther, Pollen and Ovule & Ovary culture

Production of haploid plants and homozygous lines

Cryopreservation for germplasm conservation

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

**Plant molecular biology**

Gene structure, expression, and regulation in plants

*Agrobacterium tumefaciens* for 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-VI:** **(15 L)**

**Transgenic Crops**

Crops with resistance to biotic stresses, viruses, fungal and bacterial diseases

Crops with resistance to abiotic stresses

GM crops, medical applications of GM plants

Terminator technology

Ecological risk assessment of genetically modified crops

**Text & References:**

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

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

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

**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.

**Course Outcome:**

- Students would be more aware about PTC technique and lab organization with necessary explanations.
- By studying all these students would be more empower with the special skills of PTC to establish own business and create employment in the field of seed and processing and related technique in various research organizations.

**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 DNA isolation
10. Protoplast isolation
11. Synthetic seed preparation
12. Embryo culture
13. RAPD

**Rajarshi Shahu Mahavidyalaya (Autonomous), Latur**
**M.Sc. Biotechnology (Semester Pattern)**
**III Semester**
**Skill Enhancement Course**
**Course Title: Research Methodology and Scientific Report Writing**
**Course Code: P-ADC-342**
**Marks: 50** **Credit: 02**

**Course Outcomes**

- Research Methodology and Scientific Writing is course with a hands-on component, designed to educate the Postgraduate students in the basic methods and techniques of academic research in Life Sciences in general and Biotechnology in particular.
- Students would be exposed to the main components of a research framework like defining a problem, research design, data collection, ethical issues in research, scientific writing, and presentation.
- Once equipped with this knowledge, participants would be able to conduct disciplined research under the supervision of a mentor, in an area they have selected.
- Presently, it will help them to successfully complete their dissertation thesis and in future survive in professional research environments.

**Learning Objectives:**

- To develop a research orientation among the students and to acquaint them with fundamentals of research methods.
- Introducing them to the basic concepts used in research.
- 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.
- To develop an understanding of the ethical dimensions of conducting applied research.
- Learn components of scholarly writing and presentation.
- To enable the student to develop research proposal and to work with research problem

**Unit-I:** **(10 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:**

1. How to search and download literature using PubMed and other NCBI Databases.
2. Literature search using Google Scholar, and Research Gate.

**Unit-II:** **(10 L)**

**Planning of Research**

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:**

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:** **(10 L)**

**Scientific and Medical Writing**

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:**

1. Use of Software for formatting of the scientific reports/publications like MS Office/MS Excel. Use of Software for formatting the Bibliography/References.
2. Use of MS Powerpoint for slide preparation/Presentations.

**Text & References:**


1. Research Methodology: Methods and Techniques, New Age International Publishers, ISBN:81-224-1522-9. Kothari C. R. (1990)
2. Quantitative Techniques, New Delhi, Vikash publishing house. Kothari, C. R. (2005)
3. Development of Research Tools, New Delhi Shree Publishers. Gautam, N. C. (2004)
4. Research Methodology and Statistical Techniques, Deep and Deep Publications. Gupta, Santosh (2005)
5. Research Methodology: a step-by-step guide for beginners (3rd edition). London, UK: TJ International Ltd, Padstow, Corwall. Kumar, R. (2011).
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11. An Introduction to Research Methodology, RBSA Publishers. Garg, B. L.Karadia R. Agrawal, F. and Agrawal U. K. (2002)
12. Experimental Design for the Life Sciences. Oxford University Press. Ruxton & Colegrave.
13. Experimental Design for Biologists. Cold Spring Harbor Laboratory. David J. Glass.
14. A Field Guide for Science Writers. Oxford UP. Blum (1997)
15. Angier Best American Science Writing or Dawkins Oxford Book of Modern Science Writing.
16. How to Write and Publish a Scientific Paper. 6th Edition. Authors: ISBN: 0-313-33040-9. Robert A. Day and Barbara Gastel.
17. Critical steps to succeed and critical errors to avoid. Springer, NY. 241 pages. ISBN:0-387-95555-0. Alley, M. (2003) The Craft of Scientific Presentations

18. Complete Concepts and Techniques by Cengage Learning Inc. Gary B. Shelly, Thomas J. Cashman, Misty E. Vermaat, Microsoft Office Word 2007
19. How to Do Everything with Microsoft Office Excel 2007, McGraw-Hill Guy Hart-Davis
20. Learning Microsoft PowerPoint 2007 by Pearson Education. Catherine Skintik

**Rajarshi Shahu Mahavidyalaya (Autonomous), Latur**
**M.Sc. Biotechnology (Semester Pattern)**
**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 and proteomics
- To Understand applications of genomics and pharmacogenomics in clinical settings
- Provide an example of pharmacogenomics
- Appreciate possible ethical and legal issues

**Course outcomes:**

- Be able to describe the development of Omics technologies, with emphasis on genomics and proteomics;
- Be able to synthesize information to discuss the key technological developments that enabled modern genomic and proteomic studies;
- Be able to describe advanced genomics and proteomics technologies and the ways in which their data are stored;
- Be able to use bioinformatics techniques to query examples of genomic and proteomic databases to analyze cell biology;
- Be able to describe the different types of genome variation and their relationship to human diseases;
- Be able to discuss how biological systems information relating to genes, proteins and cellular structures can be used to model living cells, and even to create new synthetic cells.
- Gain the ability to use information technology to acquire relevant knowledge for their understanding of the current status of the field and its relevance to society.
- Gain the capacity to integrate knowledge across other disciplines in biotechnology.

**Unit-I:** **(15 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:** **(15 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 cause diseases, Pharmacogenomics, Ethical Consequences of Genomic Variations.

**Unit-III:** **(12 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:** **(18 L)**

**Proteomics**

Introduction, Protein 3D Structures, Protein identifications (2-hybrid system, 2-D gel electrophoresis, mass spectrometry, Methods of ionisation, Mass analyser, MALDI-TOF, application of NMR, Mining of protein databases, applications to human disease studies;

**Text & References:**

1. Discovering Genomics, Proteomics, & Bioinformatics. Campbell &Heyer (2003) Pearson Education, ISBN: 0-8053-4722-4

2. Bioinformatics, Methods of Biochemical Analysis Series Vol. 43, Baxevanis& Ouellette (2001) John Wiley & Sons, ISBN 0-471-38391-0

3. Computational Molecular Biology.Pevzner, P.A. (2000) MIT Press, ISBN: 0262161974

4. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. Andreas D. Baxevanis& B. F. Francis Ouellette (2004). 3rd Edition. Wiley & Sons, ISBN:0-471-47878-4

**Rajarshi Shahu Mahavidyalaya (Autonomous), Latur**
**M.Sc. Biotechnology (Semester Pattern)**
**IV Semester**
**Course Title: Advanced Pharmaceutical Biotechnology**
**Course Code: P-PHB-433**
**Marks: 100 Lectures: 60 Credit: 04**

**Learning Objective:**

- 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

**Course Outcome:**

- After completion of the course the students would be able to make themselves more employable in pharma industries.
- They will be well acquainted with different aspects of drug development. They will gain preliminary knowledge of clinical trials.

**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 an 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**

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 Trials**

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.

**Text & References:**


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

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

**Course Title: Lab Course XIII** **Course Code: P-LAC-436**
**Marks:50** **Credit: 02**

**Learning Objective:**

- 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.

**Course outcomes:**

- Be able to discuss how biological systems information relating to genes, proteins and cellular structures can be used to model living cells, and even to create new synthetic cells.
- Gain the ability to use information technology to acquire relevant knowledge for their understanding of the current status of the field and its relevance to society.
- Gain the capacity to integrate knowledge across other disciplines in biotechnology.
- To understand the social issues and Problems related to Biological Fields.
- Skills in writing Research, Business Proposals.

**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

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

**Course Title: Food and Nano Biotechnology Course Code: P-FNB-434**
**Marks: 100 Lectures: 60 Credit: 04**

**Learning Objective:**

- The course involves diverse areas of food biotechnology with strong focus on Biochemistry and Molecular Biology which will form the basis for designing food ingredients for better health and microbial food safety.

**Course Outcome:**

- Discuss applications, advantages and limitations of enzymes in the food industry.
- Describe developments in the field of functional dairy products.
- Describe examples of the application of omics techniques in food analysis: food authenticity, food safety.
- Critique strategies to engineer flavour profiles in plants and food materials.
- Plan a safety assessment strategy for food developed through genetic engineering.
- Outline the major technical considerations for detecting GM foods and for species identification in meat products.

**Unit-I:** **(12 L)**

**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:** **(15 L)**

**Fermented Food Products**

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:** **(16 L)**

**Techniques**

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 Neutraceuticals

**Unit-IV:** **(18 L)**

**NanoBiotechnology**

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.

**Text & References:**


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

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

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

**Learning Objectives**:

- To have understanding of environment
- To know technical aspects of biotechnology to improve environment.
- To help the students to build interdisciplinary approach
- To inculcate sense of scientific responsibilities and social and environment awareness.

**Course Outcome**

- Explain the importance of microbial diversity in environmental systems, processes and biotechnology
- Understand and explain the importance of molecular approaches in environmental microbiology and biotechnology.
- Describe existing and emerging technologies that are important in the area of environmental biotechnology;
- Describe the principles and techniques underpinning the application of biosciences to the environment;
- Describe biotechnological solutions to address environmental issues including pollution, mineral resource winning, renewable energy and water recycling;
- Analyse case-studies representative of key areas of environmental Biotechnology;
- Undertake a range of practical approaches relevant to environmental microbiology and biotechnology and be able to record, report and discuss data

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

**Ecology & Environment**

Ecosystem structure and functions, abiotic and biotic component.

Energy flow, food chain, food web.

Ecological Pyramids-types.

Biogeochemical cycles.

Ecological succession.

Sustainable management and conservation of environment.

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

**Environmental Pollution**

Classification of pollutants.

Air pollution- causes, effects & control strategies.

Water pollution - causes, effects & control strategies.

Air borne diseases, Water borne diseases.

Environmental pollution associated hazards.

Greenhouse effect and global warming.

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

**Biotechnological processes**

Waste water treatment plant:

Physical, Chemical and Biological unit operations/processes-overview, Activated Sludge Process, Trickling Filters, anaerobic biological treatment process – UASB Reactor

**Biotechnology in Remediation**

Introduction to bioremediation.

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.

**Text & References:**


1. Environmental Biotechnology - Allan Stagg.
2. Environmental Biotechnology by Prof. Jogdand, Himalayan publication
3. Environmental Biotechnology, Ellis Horwood Ltd. Foster C.F., John Ware D.A.,
4. Biotechnology and Biodegradation, Karrely D., Chakrabarty K., Omen G.S.
5. Bioremediation engineering; design and application John. T. cookson,Jr. Mc Graw Hill, Inc.
6. Environmental Biotechnology by A.K. Chatterjee
7. Environmental Biotechnology: Bimal Bhattachraya and Ritu Banerjee
8. Environmental pollution control engineering. C. S. Rao. New Age International Publishers.
9. Environmental Biotechnology theory and application by Gareth Evans and Judith Furlong. John Wiley and Sons Ltd.
10. Environmental Biotechnology Concept and application edited by Hans-Joachim Jördening and Josef Winter. Wiley VCH Verlag GmbH & Co. KGaA

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

**Course Title: Lab Course XIV** **Course Code: P-LAC-437**
**Marks: 50** **Credit: 02**

**Learning Objectives**:

- To have understanding of environment.
- To know technical aspects of biotechnology to improve environment.
- To help the students to build interdisciplinary approach.
- To inculcate sense of scientific responsibilities and social and environment awareness.

**Course Outcome:**

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

**Practicals:**

1. Isolation and Characterization of food fermenting organism from idli,butter.
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 toleranceii) 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.

| Sr. No. | Cross Cutting Issues | Related course |
|---|---|---|
| 1. | **Gender Sensitization** | _ |
| 2. | **Environment & Sustainability** | Plant Biotechnology<br><br>Food and Nano-Biotechnology<br><br>Environmental Biotechnology |
| 3. | **Human Values** | _ |
| 4. | **Professional Ethics** | Research Methodology and Scientific Report Writing |

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