



Shiv Chhatrapati Shikshan Sanstha's
Rajarshi Shahu Mahavidyalaya, Latur
(Autonomous)

Department of Biotechnology

Curriculum
For the Academic Year 2021-22
Under CBCS

Two Year Degree Programme in Biotechnology
(Four Semester Programme)
(CC/DSE/SEC)

PG First Year
Semester I and II

Syllabus Approved by Board of Studies in Biotechnology with effect
from June, 2021

Rajarshi Shahu Mahavidyalaya, Latur
(Autonomous)
Department of 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 (Autonomous), 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 needs 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, State Government guidelines and UGC. The programme outcome is given in the curriculum and displayed on 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 at the beginning of programme.

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 has a strong recommendation for job oriented syllabus to be included. Accordingly, the necessary changes have been effectively implemented in Curriculum.

4. Programme Specific outcomes/ Programme Outcomes:

At the end of the program the student will 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.
- induce the understandings of basic principles of process units operations of industrial products with hands-on practices for implementation of such techniques to facilitate the development of biopharmaceutical manufacturing.

- gain fundamental knowledge of molecular biotechnology, protein expression, and structural biology for the development of new products having clinical application.
- plan, conduct, execute and write-up a proposal of original research Practical skills.
- integrate fundamental concepts of leadership, entrepreneurship and innovation, financial decision making and marketing to business enterprises.
- equip the students with the skills required for carrying out research in cutting edge areas of life sciences
- make the students competent for dealing with the future problems and challenges of regional and global interest in overall development of society
- promote the entrepreneurship for self-growth and sustainability with the aim of promoting lab to land practices in, clinical, agriculture, food, nano and animal biotechnology

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 come under the umbrella of Biotechnology e.g. Biochemistry, Animal Biotechnology and Immunology and Immuno-techniques etc.

6. Duration of the Course:	Two years
7. Eligibility of the Course:	B.Sc. Science
8. Strength of the Students:	90
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 books 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, Latur
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Department of Biotechnology
Choice Based Credit System
Course Structure of M.Sc. Biotechnology First Year

M. Sc. I [Biotechnology] Semester I

Code No.	Course Title	Hours/ Week	Marks (100)		Credits	Marks
			In Sem	End Sem		
P-CCB-134	Cell and Cancer Biology	04	40	60	04	100
P-BIO-135	Biochemistry	04	40	60	04	100
P-MIP-136	Microbial Physiology	04	40	60	04	100
P-BIB-137	Bioinstrumentation and Biostatistics	04	40	60	04	100
P-LAC-138	Lab Course I	04	20	30	02	50
P-LAC-139	Lab Course II	04	20	30	02	50
P-LAC-140	Lab Course III	04	20	30	02	50
P-LAC-141	Lab Course IV	04	20	30	02	50
	Total Credits/Marks	32			24	600

M.Sc. I [Biotechnology] Semester II

Code No.	Title of the Course	Hours/ Week	Marks (100)		Credits	Marks
			In Sem	End Sem		
P-MOB-232	Molecular Biology	04	40	60	04	100
P-IMI-233	Immunology and Immunotechniques	04	40	60	04	100
P-ANB-234	Animal Biotechnology	04	40	60	04	100
P-BIE-235	Bioprocess Engineering	04	40	60	04	100
P-LAC-236	Lab Course V	04	20	30	02	50
P-LAC-237	Lab Course VI	04	20	30	02	50
P-LAC-238	Lab Course VII	04	20	30	02	50
P-LAC-239	Lab Course VIII	04	20	30	02	50
P-Sem-240	Seminar	03	50		02	50
	Total Credits/Marks	35			26	650

Rajarshi Shahu Mahavidyalaya, Latur
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M.Sc. Biotechnology (Semester Pattern)
I Semester

Course Title: Cell and Cancer Biology

Course Code: P-CCB-134

Marks: 100

Lectures: 60

Credit: 04

Learning Objectives:

- To understand the structures and functions components of cell organelles.
- To know the communication between cells and related cell signaling.
- To understand the basics of cell cycle and cell division.
- To understand cellular and molecular aspects of cancer

Course Outcomes:

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

- describe cell organelles and related functions of the cell.
- understand the cell signaling concepts and its significance.
- explain the process of cell division and cell cycle.
- understand and interpret the cellular and molecular aspects of cancer

Unit I:

(14 L)

Cell Introduction

Cell as the basic unit of life, History & Evolution, Salient features of cell. Prokaryotes vs eukaryotes, Plant cell vs Animal cell. Schleiden & Schwann's cell theory, Modern cell theory, Significance of cell theory. Structure and function of cell membrane, Fluid-Mosaic Model and its components.

Membrane Transport: Non-mediated transport, Mediated transport - Passive transport, Active transport, Bulk transport. Membrane Potential & Transmission of nerve impulse.

Unit II:

(16 L)

Cell organelles

Structural organization & functions of intracellular organelles: Cell wall, Nucleus, Mitochondria, Golgi bodies, Lysosomes, Endoplasmic reticulum, Peroxisomes, Plastids and chloroplast, Vacuoles. Function & structure of cytoskeleton & its role in motility.

Unit III:

(14 L)

Cell signalling

Introduction, Stages of cell signalling.

Signal transduction: Concept, Factors determining signal transduction pathways. Signal amplification process.

Cell receptors: Introduction and Types of receptors.

Secondary messengers: Introduction & classes of second messengers. G - proteins in signal transduction.

Unit IV:

(16L)

Cell Cycle

Introduction, Phases of cell cycle, Cell cycle regulation, Cell Cycle checkpoints. Mechanism of apoptosis.

Cancer: Introduction, Benign tumour, Malignant tumour, Properties of cancer cells.

Molecular basis of cancer: Cancer critical genes; proto-oncogenes, tumour suppressor genes, carcinogen, oncovirus. Therapeutic interventions of uncontrolled cell growth.

Recommended Textbooks and References:

1. Lodish et al. (2004). Molecular Cell Biology (Scientific American Book)
2. Alberts et al. (2002). The Biology of the Cell
3. Cooper & Hausman. (2004). The Cell – A Molecular Approach
4. De Robertis, E.D.P. and Robertis, E.M.F. (1991). Cell and molecular biology. Lea and Febiger
5. David Sadava (1993): Cell and Molecular biology- Jones & Bartlett Publishers
6. Gerald Karp (1993): Cell & molecular biology -: John Wills
7. EB Wilson (1896). The Cell in Developmental and Inheritance-, MacMilan New York
8. F T logo (1987) Fertilization Chapman and Hall.
9. LP Freedman (1998) Molecular Biology of Steroid and Nuclear Hormone Receptors. Springer Verlag
10. J. Sambrook (2001). Molecular Cloning: a Laboratory Manual - CSHL Press,
11. T.A. Brown (2006). Genomes – Garland Science

Rajarshi Shahu Mahavidyalaya, Latur
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M.Sc. Biotechnology (Semester Pattern)
I Semester

Course Title: Lab Course I
Marks: 50

Course Code: P-LAC-138
Credit: 02

Learning Objectives:

- To understand different cells and cell diversity.
- To understand the structures and purposes of basic components of cells.
- To understand cell division in plants and animals.
- To help in understanding the basics of cell organelles with practical experience.

Course Outcomes:

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

- separate and characterize subcellular components of cells.
- Use cellular techniques in research and diagnostics.
- identify and describe the cellular structure of organs and tissues from prepared slides, and outline the principles of histochemical staining.
- perform experimental techniques as instructed making accurate observations; record, analyze and interpret data.

Practicals:

1. Cellular diversity
2. Cellular permeability
3. Study of Mitosis (root tips)
4. Study of Meiosis (anthers)
5. Lipid solubility of membrane.
6. Study of karyotypes.
7. Isolation of chloroplast.
8. Analysis of chlorophyll amount by Spectrophotometer.
9. Isolation of Mitochondria.
10. vital staining of Mitochondria.
11. Vital staining of lipid and glycogen bodies.
12. Cell types of plants- Microtomy/ maceration of various tissue explants and identification.
13. Buccal smear- Identification of Barr body.

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(Autonomous)
M.Sc. Biotechnology
I Semester

Course Title: Biochemistry
Max. Marks: 100

Lectures: 60

Course Code: P-BIO-135
Credits: 04

Learning Objectives:

- To learn about the importance of bioenergetics, buffers and biological interactions.
- To study structure, classification and functional importance of Biomolecules.
- To study fundamentals of structures and interactions present in various biomolecules that help in functioning and organization of living cell.
- To understand biochemical pathways for synthesis and breakdown of complex biomolecules and metabolic disorders that arises out of malfunction of metabolic pathways.

Course Outcomes:

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

- describe redox couples and redox potentials.
- demonstrate the structural and functional role of biomolecules essential for cellular reactions.
- know how the simple precursors give rise to large biomolecules such as proteins, carbohydrates, lipids and nucleic acids.
- explain the physiological significance of anabolic and catabolic pathways used to drive cellular functions.

Unit I:

(10 L)

Principles of Bioenergetics

Introduction, Thermodynamic principles, Gibbs free energy, Relationship of Standard free energy to enthalpy, entropy and equilibrium constant, High energy compounds, ATP as universal currency of free energy, Redox Reactions and free energy change in redox reactions.

Structure of atom, Henderson- Hasselbalch equation pH, buffers, Stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.).

Unit II:**(16 L)****Carbohydrates and its Metabolism**

Carbohydrates: Introduction, Monosaccharides: Properties and functions with example, Derived sugars- Sugar acids, Sugar alcohols, Glycosides, Amino sugars. Disaccharides- structures of Maltose, Lactose, Sucrose, Polysaccharides structure and properties of homo and hetero polysaccharides with examples (Starch, Glycogen, Cellulose, Chitin, Glycosaminoglycans).

Carbohydrate metabolism (Energetics and regulation): Glycolysis, Citric acid cycle, Pentose phosphate pathway, Gluconeogenesis.

Unit III:**(17 L)****Lipids and Nucleic acid**

Lipids: Classification- Structure, properties, reactions and biological functions of lipids. Phospholipids, Sphingo and glycolipids, Steroids-cholesterol-bile salts, steroid hormones. **Metabolism of Lipids:** Beta oxidation of Fatty acids-activation, transport to mitochondria, Biosynthesis of saturated and unsaturated fatty acids and cholesterol.

Nucleic acids: Structure and properties- Bases, Nucleosides, Nucleotides, Polynucleotides.

Nucleic acid metabolism: Biosynthesis of purines and pyrimidines, Denovo and Salvage pathways, biodegradation of purines and pyrimidines

Unit IV:**(17L)****Amino acids and Proteins**

Amino acids: Classification, structure and properties of amino acids, reactions of amino acids, peptide bond. General aspects of amino acid metabolism: Transamination, Deamination, urea cycle and its regulation

Protein structure: Classification of proteins with examples (Collagen, Keratin, Hemoglobin and Myoglobin), Structural organizations of proteins (primary, secondary, tertiary and quaternary), conformational analysis, Ramachandran's plot.

Recommended Textbooks and References:

1. Jain, J.L., Jain, S. and Jain, N.,(2005), Fundamentals of Biochemistry, S. Chand and Company Ltd.
2. Nelson, D.L., Cox, M.M. Lehninger. (2004). Principles of Biochemistry 4th edition Pub.WH Freeman Co.

3. Berg JM, Tymoczko JL and Stryer L, (1995). Biochemistry 4th Edition, WH Freeman and Company.
4. Voet, D., Voet J.G. (2004). Biochemistry 2nd Edition, John Wiley & Sons, Inc.
5. Zubey, G.L. Parson, W.W., Vance, D.E. (1994). Principles of Biochemistry WmC Brown publishers. Oxford
6. Conn and Stumpf (1967). Outlines of Biochemistry, New York Wiley
7. Plummer DT (1988). An Introduction to Practical Biochemistry, Tata McGraw-Hill Publishing Company Limited.
8. Kuchel, P.W., Ralston Schaums, G.B. (2003). Outlines of Biochemistry 2nd edition Pub: Tata.
9. Elliott, W.H., Elliott, D.C. (2005). Biochemistry and Molecular Biology 3rd Indian edition, Pub. Oxford press.

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

Course Title: Lab course II
Marks: 50

Course Code: P-LAC-139
Credit: 02

Learning Objectives:

- To teach how to prepare standard solutions and Buffers.
- To make understand to analyze the given Biomolecules qualitatively and quantitatively.
- To understand how to analyze biomolecules by separation techniques.
- To understand qualitative estimation of biomolecules.

Course Outcomes:

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

- prepare different solutions and buffers.
- estimate the unknown concentration of Biomolecules
- use current biochemical techniques to plan and carry out experiments.
- analyze biomolecules by separation techniques

Practicals:

1. Calibration of instruments and verification of Lambert-Beer's Law
2. Preparation of Standard solutions
3. Preparation of buffers
4. Determination of pK values of amino acid
5. Determination of acid value, Saponification number and iodine Number of fatty acids
6. Estimation of protein by Lowry, Biuret and Bradford methods.
7. Estimation of amino acid by Ninhydrin method.
8. Estimation of sugar by Anthrone and DNSA method.
9. Estimation of DNA and RNA by Spectrophotometric method
10. Purification of compound by Column Chromatography

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

Course Title: Microbial Physiology

Course Code: P-MIP-136

Marks: 100

Lectures: 60

Credit: 04

Learning Objectives:

- To study and understand the microbial world and its diversity.
- To understand pure culture techniques and media required for microbial growth.
- To learn bacterial growth curves and kinetics
- To acquire knowledge on basic aspects of bacterial respiration and photosynthesis.

Course Outcomes:

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

- describe basic structure and functions of microbes and relationship to the environment.
- get acquainted with pure culture techniques.
- explain microbial growth kinetics.
- describe bacterial metabolism.

Unit I:

(17 L)

Beginning of Microbiology

Discovery of the microbial world by Antony van Leeuwenhoek; Controversy over spontaneous generation, Role of microorganisms in transformation of organic matter and in the causation of diseases; Development of pure culture methods; Enrichment culture methods, developments of microbiology in the twentieth century.

Knowing of Microbial world: Bacteria: Purple and green bacteria, cyan bacteria, Homoacetogenic bacteria. Acetic acid bacteria, Budding and appendaged bacteria, Spirilla, Spirochetes, Sheathed bacteria, Pseudomonads; Lactic and propionic acid bacteria, Endospore forming rods and cocci, Mycobacterium, Rickettsias, Chlamydiae and Mycoplasma.

Archaea: Halophiles, Methanogens, Thermoplasma, Ferroplasma and Hyperthermophilic archaea.

Eukarya: Algae, Fungi, Slime moulds and Protozoa.

Viruses: Bacterial, Plant, Animal and Tumor viruses; Viroids and Prions.

Unit II :

(13 L) Pure Culture t

Pure culture techniques, Theory and practice of sterilization, Enrichment culture techniques. New approaches to bacterial taxonomy classification including Ribotyping; Ribosomal RNA sequencing; Taxonomy, Nomenclature and Bergey's Manual.

Unit III:

(14 L)

Microbial Growth

The definition of growth, mathematical expression of growth, growth curve, measurement of Growth and growth yields; Synchronous growth: Continuous culture; Growth as affected by Environmental factors like temperature, acidity, alkalinity, water availability and oxygen; Culture collection and maintenance of cultures.

Unit IV:

(16 L)

Overview of Basic Metabolism and Microbial Nutrition

Metabolic Diversity among Micro-organisms Photosynthesis in microorganisms; Role of Chlorophylls, carotenoids and phycobilins; Calvin cycle; Chemolithotrophy; Hydrogen - iron - nitrite - oxidizing bacteria; Nitrate and sulfate reduction; Methanogenesis and acetogenesis: Fermentations - diversity, syntrophy

Recommended Textbooks and References:

1. Stainer, R. Y. Ingraham, E. A. Adelberg. (1999), General Microbiology, 4th Edition, The MacMillan Press Ltd.
2. M.T. Madigan, J. M. Martinko, Brock. (2010), Biology of Microorganisms, 13th Edition, Benjamin Cummings Ltd.
3. Pelczar, M.J., Chan, E.C.S. and Kreig, N.R. (2002), Microbiology, 5th Edition, Tata McGraw Hill.
4. Maloy, S.R., Cronan, J.E. Jr. and Freitelder, D. Jones. (1994), Microbial Genetics, 2nd Edition, Bartlett Publishers.
5. Cappuccino, J.G. and Sherman, N. Addison Wesley. (2014), Microbiology - A Laboratory Manual, 10th Edition,
6. Benson, H.J. WCB: Wm C. (2014), Microbiological Applications (A Laboratory Manual in General Microbiology), 13th Edition, Brown Publishers.

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

Course Title: Lab Course III
Marks: 50

Course Code: P-LAC-140
Credit: 02

Learning Objectives:

- To learn media preparation and sterilization
- To study isolation and maintenance of Microorganism.
- To provides hands-on pure culture and staining technique
- To study growth curve and effect of environmental factors on the growth of microorganisms.

Course Outcomes:

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

- prepare solid and liquid media.
- isolate microbes by using pure culture techniques
- characterize microbes Morphologically and Biochemically
- perform growth kinetics

Practicals

1. Preparation of liquid and solid media for growth of microorganisms.
2. Isolation and maintenance of organisms by plating, streaking and serial dilution Methods. Slants and stab cultures. Storage of microorganisms.
3. Isolation of pure cultures from soil and water.
4. Bacterial Growth: Growth curve.
5. Measurement of bacterial population by turbidometry and serial dilution methods.
6. Effect of temperature, pH and carbon sources on growth.
7. Microscopic examination of microorganisms and study of organisms by Monochrome staining, Negative Staining and Gram staining.
8. Assay of Antibiotics

9. Analysis of water for portability and determination of MPN.
10. Biochemical characterization of selected microbes.

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(Autonomous)

M.Sc. Biotechnology (Semester Pattern)

I Semester

Course Title: Bioinstrumentation and Biostatistics

Course Code: P-BIB-137

Marks: 100

Lectures: 60

Credit: 04

Learning Objectives:

- To understand analytical techniques and equipment used in biological sciences.
- To understand the basic principle and applications of microscopy and centrifugation.
- To acquire knowledge on the Chromatographic and electrophoretic method for the separation of biological molecules.
- To study statistical methods pertaining to life sciences

Course Outcomes:

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

- apply analytical techniques in the field of biological sciences.
- acquaint the knowledge of microscopy and centrifugations techniques.
- get proficiency in chromatography and spectroscopy techniques.
- analyze the biological data using statistical tools

Unit-I

(13 L) Microscopy, Ce

Light microscope, Fluorescence microscope, Phase contrast microscope, Electron microscope, confocal microscopy.

Centrifugation: Principle of centrifugation, small bench top centrifuges, large capacity refrigerated centrifuges, High speed refrigerated centrifuges, preparative and analytical ultra-centrifuge. **Electrochemical techniques:** Principles of electrochemical techniques, redox reactions, the pH electrode, ion-sensitive and gas-sensitive electrodes, The Clark oxygen electrode, Biosensors.

Unit-II

(15 L) Chromatograph

Principles of chromatography, Types of Chromatography: Paper chromatography, thin layer Chromatography, size exclusion, Ion exchange, Affinity chromatography, High

performance liquid chromatography (HPLC), Gas liquid chromatography (GLC), Reverse Phase Chromatography, Mass Spectrometry, GC-MS and LC-MS.

Electrophoresis General principles, Electrophoresis of proteins: SDSPAGE, Native gels, Gradient gel, Isoelectric focusing, 2-D gel electrophoresis (2-D PAGE), cellulose acetate electrophoresis, continuous flow electrophoresis; Detection, estimation and recovery of proteins, Electrophoresis of nucleic acids: Agarose gel electrophoresis of DNA, DNA sequencing gels, Pulse field gel electrophoresis, electrophoresis of RNA, Capillary electrophoresis.

Unit-III:

(11 L) Spectroscopy

Properties of electromagnetic radiation, interaction with matter. Gamma ray spectroscopy, X-ray spectroscopy, UV and Visible spectroscopy, Infrared and Raman spectroscopy, Electron spin resonance spectroscopy, Nuclear magnetic resonance spectroscopy, Circular dichroism spectroscopy, Atomic spectroscopy. Lasers, Spectrofluorimetry, Luminometry, turbidometry and nephelometry.

Unit-IV:

(11 L) Radioactivity

The nature of radioactivity, detection and measurement of radioactivity: detection based on gas ionization- Geiger Muller counter- principles and applications. Detection based on excitation- Liquid Scintillation counter-principle and applications. Supply, storage and purity of radiolabelled compounds, specific activity, inherent advantages and restrictions of radiotracer experiments, safety aspects, applications- of radio isotopes in biological sciences.

Flow cytometry, ELISA, Immunoblotting

Crystallization of biomolecules: Introduction to X-ray crystallography.

Unit-V

(10 L) Biostatistics

Brief description and tabulation of data and its graphical representation, Measurement of central tendency and dispersion- mean, mode, median, range, Mean deviation, standard deviation, variance. Idea of two types of errors and level of significance. Tests of significance- F-Test, and chi-square test. Linear regression and correlation.

Recommended Textbooks and References:

1. Avinash Upadhyay, Kakoli Upadhyay, Nirmalendu Nath(2009).Biophysical Chemistry,Himalaya Publishing House.
2. Keith Wilson (2005). Principles and Techniques of Biochemistry and Molecular Biology, 5thEd.s Cambridge University Press.
3. R.S. Khandpur (2004).Handbook of Biomedical Instrumentation.Tata McGraw Hill.
4. Cotrell(2002).Biophysics (Eastern Economy Edition)

5. P.Narayanan (2000).Clinical Biophysics: Principles and TechniquesBhalaniPub.,Mumbai.
6. Pattabhi and Gautham (2002).Biophysics,Narosa Publishing House.
7. R.S. Khandpur(2003).Handbook of analytical instruments Tata Mc Graw Hill.
8. Khan and Khanum (2018). Fundamentals of Biosatistics low price 3 rd. revised edition ; Ukaaz Publication.
9. S.P.Gupta (2014).Fundamental of Statistics. S. Chand publications.

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

I Semester

Course Title: Lab Course IV

Course Code: P-LAC-141

Marks: 50

Credit: 02

Learning Objectives:

- To Provide Hands-on Microscopy and Centrifugation techniques.
- To Provide Hands-on separation and purification of Biomolecules.
- To get expertise in Western Blotting and ELISA techniques used for analysis of proteins.
- To understand applications of statistical tools in analysis of biological data

Course Outcomes:

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

- identify different specimens by using microscopy.
- separate and purify biomolecules.
- separate and identify biomolecules by using blotting techniques.
- interpret the biological data using statistical tools

Practicals

1. Practical's Based on Microscopy
2. Practicals based on centrifugation
3. Practical's Based on Electrochemical Techniques
4. TLC, Paper Chromatography
5. Separation of proteins / pigments using column/Affinity chromatography
6. Demonstration of techniques: gas chromatography high performance liquid
7. Chromatography HPLC
8. Electrophoresis Of DNA
9. Electrophoresis of proteins under native and denaturing conditions (PAGE)
10. To find out isoelectric point of amino acid
11. Western blotting
12. ELISA
13. Study of Lambert's & Beer's law
14. Absorption spectrum of protein
15. Problems based on Spectroscopy and Radioactivity
16. Problems Based on Biostatistics (Central Tendency, Dispersion, Correlation and Regression ,Anova etc.)

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(Autonomous)

M.Sc. Biotechnology

II Semester

Course Title: Molecular Biology

Course Code: P-MOB-232

Marks: 100

Lectures: 60

Credit: 04

Learning Objectives:

- To understand genome organization in lower and higher organisms.
- To understand replication, mutation and repair events in both Prokaryotic and eukaryotic organisms.
- To understand central dogma of life and gene flow.
- To know gene regulation and its application.

Course Outcomes:

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

- extend understanding of the molecular mechanisms via which genetic information is stored, expressed and transmitted among generations.
- understand the principles of inheritance at molecular level.
- understand the synthesis, structure, and function of nucleic acids replication in prokaryotes and eukaryotes.
- understand the flow of genetic information in populations and the relationship between genetics and evolutionary theory.

Unit I

(14 L)

Genome organization:

Genome organization of Prokaryotes-Bacteria and virus system. Genome organization of Eukaryotes- Structure and types of chromosomes, chromatin and nucleosome, Variation in chromosome number, Concepts of ploidy, conditions and types of ploidy, variation in chromosome structure, Denaturation and Renaturation DNA, C-value paradox, Cot curve.

Unit II

(16 L)

Genome replication:

DNA as genetic material, Genome Replication in prokaryote, various modes of DNA replication, enzymes involved, Initiation elongation and termination, Replication regulation in Eukaryotics, enzymes involved, Molecular basis of genome evolution: Mutations, causes types and effects, Hyper mutation, DNA Repair, Recombination: homologous, site specific, transposition

Unit III

(17 L)

Transcription:

Initiation, elongation and termination, Post transcriptional processing of m-RNA, t-RNA, r-RNA.

Translation: Initiation, elongation and termination, post translational modifications of proteins- Chemical modification, intron splicing, protein folding and protein localization.

Gene regulation in prokaryotes: - Operon concept, Lactose, Tryptophan and Arabinose. Role of cAMP and CRP in lac operon, tryptophan operon, Catabolite repression

Gene regulation in eukaryotes: -Conserved mechanism, activation and repressor role in gene regulation.

Unit IV

(13 L)

Basic concepts of developmental biology

Zygote formation, Embryogenesis, organogenesis and morphogenesis. Study of molecular development of Drosophila, gene regulation. Molecular development of Arabidopsis as model organisms, Homeobox-gene expression, Role of RNAi in development.

Recommended Textbooks and References:

1. William S. Klug and Michael R. Cummings (2005) Concepts of Genetics (International Edition) Edition: Seventh Pearson.
2. T.A. Brown, (2002) Genome2 2nd Edition John Wiley.
3. Lodish, Berk-Freeman (2003) Molecular Biology 7th edition Pub. Molecular Biology of the Cell Macmillan publications.
4. Benjamin A. Pierce(2010) A conceptual Approach; 6th edition Genetics:
5. Albert Bruce, (2005) Molecular Biology of the Cell, Garland Science Publication.
6. T.A Brown, John Wiley (2006) Genetics a Molecular Approach,
7. Scott F. Gilbert (2003).Developmental Biology V ed Sinahauer associate Pub.
8. G.S.Miglani(2013).Developmental genetics, I.K.InternationalPub.

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

Course Title: Lab course V
Marks: 50

Course Code: P-LAC-236
Credit: 02

Learning Objectives:

- To provide Hands-on Nucleic acid isolation using various sources
- To study quantitative analysis of nucleic acids
- To provide Hands-on genome transformation.
- To study gene expression pattern

Course Outcomes:

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

- develop skills in isolation and purification of genomic DNA, plasmid DNA and RNA.
- separate and purify nucleic acids based on charge.
- apply the skills of genome transformation in research.
- develop auxotroph's by using replica plating technique.

Practicals:

1. Genetic recombination (conjugation, transformation, transduction) in bacteria.
2. Isolation of genomic DNA from bacteria, animal and plant cells.
3. Isolation of plasmid DNA by using alkaline lysis method.
4. Agarose gel electrophoresis by using DNA markers for molecular wt. determination.
5. Isolation of antibiotic resistant bacteria by gradient plate method.
6. Replica plating for transfer of bacterial colony.
7. Study of Hens embryo for developmental stage study.
8. Study of in vitro transcription and translation
9. Study of mutations: Ames test
10. Isolation of RNAs

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

Course Title: Immunology and Immuno-techniques **Course Code: P-IMI-233**
Marks: 100 **Lectures: 60** **Credit: 04**

Learning Objectives:

- To understand cells and organs of Immunology.
- To study basics of antigen, antibody and MHC molecules.
- To study clinical immunology with respect to various diseases.
- To study various immune-techniques of immunology.

Course Outcomes:

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

- understand the working of cells and organs of Immunology.
- explain the properties of antigen, antibody and MHC molecules.
- discuss the clinical aspects of Immunology.
- describe various antigen-antibody reactions and their Significance.

Unit I

(154L)

Overview of Immunology

The origin of immunology, Innate and Adaptive Immune response. Haematopoiesis, Cells of Immune system and their biological role. Humoral and cell mediated Immunity. Primary and Secondary immune responses. The Primary and secondary lymphoid organs.

Antigen Processing and Presentation: MHC molecules, Antigen processing and presentation (antigen presenting cells, endocytic, cytosolic pathway).

Cytokines and signal transduction.

Unit II

(15 L)

Basics of Immunology

Antigen: Characteristics of antigen, types, Factors that Influence Immunogenicity, Epitopes, Haptens, Antigenicity and Immunogenicity, adjuvant and its types.

Antibody: Discovery of antibody structure by chemical and enzymatic Methods. General Structure of antibody molecule, Function of antibody molecule. Affinity and Avidity, Valency of Antibody. Antibodies- Types, variation in structure of antibody.

Organization and Expression of Immunoglobulin Genes.

Antibody Antigen interactions: Strength of Antigen-Antibody Interactions, Cross-Reactivity. **Immunological reactions:** Precipitation and Agglutination reactions, Radioimmunoassay, ELISA, Western Blotting, Flow cytometry and Fluorescence, Immuno-electron microscopy, chemiluminescence assay, CFT.

Unit III

(15 L)

Clinical Immunology

Complement system: Activation of Complement systems (alternative, classical & lectin pathway) and its Functions.

Hypersensitivity: Hypersensitivity reactions and its types.

Immunodeficiency Conditions: Immunodeficiency: Primary immunodeficiency (SCID), Secondary immunodeficiency (AIDS)

Autoimmunity: Organ specific autoimmune diseases and Systemic autoimmune diseases. **Tumor Immunology:** Tumor Antigens, Cancer Immunotherapy

Unit IV

(16 L)

Immuno Technology

Transplantation Technology: Types of graft (auto, Iso, Allo, and xeno graft), Specificity and memory of rejection response, Mechanisms involved in graft rejection.

Vaccine Technology: Active and Passive Immunization. Type of Vaccines.

Antibody engineering: Phage display, large scale production of MAb antibodies, Applications of MAb in diagnosis and therapy.

Recommended Textbooks and References:

1. Kuby, Judy Owen, Jenni Punt, Sharon Stanford. (2007). Immunology, 8th Edition WH Freeman Publishers.
2. Kuby, Judy Owen, Jenni Punt, Sharon Stanford., (2003). Immunology, WH Freeman Publishers, 5th Edition
3. Tizard, Ian R. (1995). Immunology- An Introduction, 4th edition, Saunders College Publishing, New Delhi.
4. Roitt I. (2017). Essential Immunology, 13th edition, Blackwell Scientific Publications,
5. Abbas, Lichtman, Pillai (2017). Cellular & Molecular Immunology, Pillai. 6th ed. Elsevier publications.
6. Butterworth & Heinemann (1993). Cellular interactions & Immunobiology BIOTOL series.
7. Warren Levinson (2018). Review of Medical Microbiology & Immunology 9th ed. Mac Graw Hill publications.
8. B. Hannigan. (2009). Immunology Viva books Pvt. Ltd.
9. K.R. Joshi, N.O. Osamo (2013). Immunology & Serology. Student edition.

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

Course Title: Lab course VI

Course Code: P-LAC-237

Marks: 50

Credit: 02

Learning Objectives:

- To study basic immunological techniques.
- To study various antigen-antibody reactions.
- To study cells & organs of Immunology.
- To provide hands-on experiments of Hematology.

Course Outcomes:

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

- deliberate diagnosis of disease with help of kit based practicals.
- describe structure of cells and organs of immunology using microscopy.
- identify the pattern of Ag – Ab interactions.
- Perform hematological experiments.

Practicals

- 1 Agglutination reaction
- 2 Latex agglutination
- 3 Immunoprecipitation
- 4 Radial immunodiffusion
- 5 Ouchterlony Double diffusion
- 6 Immuno-electrophoresis.
- 7 Rocket immune-electrophoresis.
- 8 Crossed antigen-antibody electrophoresis.
- 9 Blood film preparation and identification of cells
- 10 Microscopic observation of lymphoid organs
- 11 Widal
- 12 VDRL
- 13 Determination of bleeding time
- 14 Determination of clotting time
- 15 Western blotting.
- 16 Immunofluorescence.
- 17 complement fixation test

Rajarshi Shahu Mahavidyalaya, Latur
(Autonomous)

M.Sc. Biotechnology

II Semester

Course Title: Animal Biotechnology

Course Code: P-ANB-234

Marks: 100

Lectures: 60

Credit: 04

Learning Objectives:

- To develop an understanding of current techniques used in biotechnology and their applications to animal sciences and the biomedical field.
- To understand transgenics and its application for human welfare.
- To understand basic cell culture and preservation techniques
- To understand the applications of Animal cell culture.

Course Outcomes:

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

- acquaint fundamentals of Animal cell culture.
- utilize skills of cell culture for development of biomolecules of clinical importance
- describe the relevance of cell cycle regulations in reference to cellular metabolism
- understand the mechanism of cellular cytotoxicity.

Unit I:

(13 L)

Cell Culture Laboratory Design and Equipments

Planning, construction and services; Layout; Sterile handling area; Incubation; Hot room; Air circulation; Service bench; Laminar flow; Sterilizer; Incubator; CO₂ incubator; Refrigerators and freezers; Centrifuge; Inverted stage microscope; Magnetic stirrer; Liquid nitrogen freezers; Slow cooling system for cell freezing; Water bath; Autoclaves and hot air oven; Pipette washers; Water purification system; Fluid handling systems and other equipments; Washing, packing and sterilization of different materials used in animal cell culture; Aseptic concepts; Maintenance of sterility; Cell culture vessels.

Unit II:

(15 L)

Cell Culture Media and Reagents

Types of cell culture media; Ingredients of media; Physiochemical properties; CO₂ and bicarbonates; Buffering; Oxygen; Osmolarity; Temperature; Surface tension and foaming; Balance salt solutions; Antibiotics, growth supplements; Foetal bovine serum; Serum

free media; Trypsin solution; Selection of medium and serum; Conditioned media; Other cell

culture reagents; Preparation and sterilization of cell culture media, serum and other reagents.

Unit III (12 L)

Cell Culture Techniques

History of animal cell culture; Different tissue culture techniques; Types of primary culture;

Chicken embryo fibroblast culture; Chicken liver and kidney culture; Secondary culture; Trypsinization; Cell separation; Continuous cell lines; Suspension culture; Organ culture etc.; Behavior of cells in culture conditions: division, growth pattern, metabolism of estimation of cell number; Development of cell lines; Characterization and maintenance of cell lines, stem cells; Cryopreservation; Common cell culture contaminants.

Unit IV: (12 L)

Applications of Cell Culture

Cell cloning and selection; Transfection and transformation of cells; Commercial scale production of animal cells, stem cells and their application; 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 V: (08 L)

Scale up Technique

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; Multisurface propagators; Multiaarray disks, spirals and tubes; Roller culture; Microcarriers; Perfused monolayer cultures; Membrane perfusion; Hollow fiber perfusion; Matrix perfusion; Microencapsulation; Growth monitoring

Recommended Textbook and References:

1. Culture of Animal Cells(2005) 5th Edition, FreshneyWiley-Liss,
2. Animal Cell Culture - Practical Approach (2000), 3rd Edition, Ed. John R.W. Masters
Oxford University Press
3. Animal Cell Culture Techniques. (1998). Ed. Martin ClynesSpringer,

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(Autonomous)

M.Sc. Biotechnology

II Semester

Course Title: Lab Course VII

Course Code: P-LAC-238

Marks: 50

Credit: 02

Learning Objectives:

- To develop an understanding of current techniques used in biotechnology and their applications to animal sciences and the biomedical field.
- To understand transgenics and its application for human welfare. Understand and discuss the social and ethical issues associated with biotechnology.
- To develop necessary skills in media preparation of ATC
- To learn about basics of Animal tissue culture

Course Outcomes:

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

- aware about basic infrastructure and culture technique of ATC.
- learn to handle cell line History, scope, principle, merits and demerits of animal cell and tissue culture.
- learn the laboratory safety and biohazards
- apply the basic laboratory knowledge in research

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.

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

Course Title: Bioprocess Engineering

Course Code: P-BIE-235

Marks: 100

Lectures: 60

Credit: 04

Learning Objective:

- To understand the fluid statics and basic of bioprocess engineering.
- To understand basic idea of designing of Bioreactor, Growth and sterilization kinetics.
- To understand the measurement and control of Bioprocesses Parameters.
- To understand upstream and downstream processing techniques.

Course Outcome:

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

- define a bacterium, a fungus, a virus and archaea, give examples of structurally different microbes, and list microbes by their energy metabolism and carbon sources.
- evaluate the cultivation, enrichment and growth prevention methods for microbes.
- explain the roles of microbes in elemental cycles on Earth and, the waste decontamination methods based on microbial activities.
- understand how microbes and enzymes could be applied in industry

Unit I:

(12 L)

Basic Chemical Engineering calculations.

Material balance. Material balance with reactions. Material balance with recycle and purge. Energy balance. Enthalpy, specific heat, mean specific heat. Heat Balance. Heat of reaction and heat of solution. Material and Energy balance together.

Fluid statics: Classification of fluids, concept of Reynold's number, Rheological properties of fermentation process (Viscosity, cell concentration, product concentration etc), Fluid mechanics. Potential flow. Newtonian and non-Newtonian fluid (Bingham plastic, pseudo plastic, dilatants etc.), Heat and mass Transfer.

Unit II:

(13 L)

Design of Fermentors and Sterilization Kinetics

Fermenters: Ideal Properties of Bioreactor, Components of the fermenters & their specifications: Body Construction, Agitator, Impeller, Baffles etc. Types of Bioreactors: (Packed-bed reactor, Air -lift, Trickle bed Photo bioreactors, Rotating Biological

Reactors pneumatic) **Air & Media sterilization:** Air Sterilization Principles, Mechanisms of capture of particles in Air, Depth & Screen Filters, Sizing, Testing & validation of filters for air sterilization, Principle of Media Sterilization, Decimal reduction, Design of sterilization cycle using kinetics of thermal death of microbes and equipments used in sterilization: Batch & Continuous Quality Control, Quality assurance, Standard Operating Procedures (SOP) & Good Manufacturing Practices (GMP).

Unit III: (17L)

Media for large-scale processes & their optimization

Constituents of media, their estimation & quantification. Design of media. Costing of media. **Strain Improvement:** Isolation, Screening, Preservations and maintenance of Microorganisms, strain improvement, Mutagenesis, Genetic Engineering for Strain Improvement. **Development of inoculum** Types of Bioprocesses: Biotransformation (enzyme, whole cell), Batch, Fed-batch, Cell recycle & continuous fermentation processes. **Growth Kinetics** : Monod model & constitutive equations used for expressing growth, substrate consumption & product formation, Solid State fermentation.

Unit IV: (18L)

Measurement & Control of Bioprocesses Parameters

Measurement & Control of Bioprocesses Parameters: Cell growth. pH, temperature, Substrate consumption, product formation, Measurement of O₂/CO₂ uptake, evolution. Specific rates of consumption substrate & formation of product. Strategies for fermentation control. Computer controlled fermentations., Foam & its control. Scale up in Bioprocesses fermentations, Factors used in scale up.

Downstream processing: Strategy for recovery, Harvesting of Biomass and Product, Removal of microbial cells and solid matter, foam separation, filtration, centrifugation, cell disruption, Liquid -liquid extraction Ext, chromatography and membrane processes, Drying and crystallization.

Bioprocess Economics, Choice of process, process analysis, fixed & variable cost, Depreciation, Amortized costs, Selection of Pricing, Profitability, Scales of operations etc.

Recommended Textbooks and References:

1. Whittaker & Stanbury (1996), Principles of Fermentation Technology, Pergamon Press.
2. Pauline Doran, (1995) Bioprocess Engineering Principles Academic Press
3. , Butterworth, Heinemann (1992) Operational Modes of Bioreactors, BIOTOL series
4. Butterworth Heinemann (1992), Bioreactor Design & Product Yield, BIOTOL series
5. B. Lydersen, N.A. Delia & K.M. Nelson (1993) Ed, Bioprocess Engineering: Systems, Equipment & Facilities John Wiley & Sons Inc,
6. G. Subramaniam, (1998) Ed Bio separation & Bioprocessing Wiley -VCH,
7. Butterworth Heinemann (1992). Product Recovery in Bioprocess Technology,

'BIOTOL series

8. Paul A. Belter, E.L. Cussler, Wei-Shou Hu(2000), Bioseparation: Downstream Processing for Biotechnology Academic Press
9. Larl Schuger, (1994) Solvent Extraction in Biotechnology. Springer-Verlag,
10. Colin Ratledge (1995), Basic Biotechnology 3rd edition Cambridge Publication
11. Bailay & Ollis (1998), Fundamentals of Biochemical Engineering 2nd edition - Tata McGraw Hill Publication
12. Mooyoung (2019). Comprehensive Biotechnology, Vol III Elsevier Publication
13. Cruger (2017). Introduction to Industrial Microbiology. ACS Publication

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

Course Title: Lab course VIII

Course Code: P-LAC-239

Marks: 50

Lecture:30

Credit: 02

Learning Objectives:

- The course involves a working understanding of tools of design of fermenters
- To Understand Engineering calculations, Growth kinetics and process kinetics.
- Able to understand basics of downstream processing.
- Able to explain and apply the principles of fermentation techniques in identifying, formulating and solving problems in the field of bioprocess technology.

Course Outcomes:

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

- Apply the understandings of bioprocess engineering, mutagenesis, protoplast fusion techniques for strain improvement for primary and secondary metabolite production
- control the upstream and downstream processing at pilot and industrial scale.
- able to use concepts of process kinetics at industrial level
- able to explain and apply the principles of the bioprocess operation unit to produce bio-products.

Practicals:

1. Study of Growth Kinetics of Bacteria and Yeast by turbidometry & SCP
2. Screening and maintenance of Industrially important microorganism- Acids, Antibiotics, Enzymes.
3. Study of scale up of fermentation
4. Study of design of bioreactor
5. Determination of TDP
6. Determination of TDT and design of sterilizer
7. Study of types of fermentation process (Surface and submerged)
8. Downstream process of industrial products (Intra & Extra cellular)
9. Problems based on: - Growth kinetics, fluid flow, Reynold's number
10. Visit to fermentation Industry

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	Cell and Cancer Biology	P-CCB-134	Professional Ethics	Expertise in cell culture techniques will create employability in Pathology labs and Research Institutes
2	Biochemistry	P-BIO-135	Professional Ethics	Expertise in cell Biochemistry will create employability in Pathology labs
3	Microbial Physiology	P-MIP-136	Professional Ethics	Students can get jobs as technician in different labs
4	Bioinstrumentation and Biostatistics	P-BIB-137	Professional Ethics	Student understands the Proper handling of instrument, which is essential in Research

				and Industry job.
5	Molecular Biology	P-MOB-232	Professional Ethics	help in getting absorb in various research organization, molecular labs and industry research and development sector
6	Immunology and immunotechniques	P-IMI-233	Professional Ethics	Expertise in immunological techniques will create employability in Pathology labs and Research Institutes
7	Animal Biotechnology	P-ANB-234	Professional Ethics	Expertise in Cell culture techniques
8	Bioprocess Engineering	P-BIE-235	Professional Ethics	Students will get job in Fermentation Industries as process design engineer.

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-CCB-134	Cell and Cancer Biology	Research and Diagnostics
2	P-BIO-135	Biochemistry	Research and Qualitative and Quantitative analysis
3	P-MIP-136	Microbial Physiology	Research
4	P-BIB-137	Bioinstrumentation and Biostatistics	Technical skills in Biology
5	P-MOB-232	Molecular Biology	Skills in Molecular Techniques
6	P-IMI-233	Immunology and Immuno Techniques	Skills in Immuno Techniques
7	P-ANB-234	Animal Biotechnology	Skills in Cell Culture Techniques, Cell line Development

8	P-BIE-235	Bioprocess Engineering	QC and QA
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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	Cell and Cancer Biology	P-CCB-134	Expertise in cell culture techniques will create employability in Pathology labs and Research Institutes		Student will get idea about cell culture Technology.	2017-18
2	Biochemistry	P-BIO-135	Expertise in cell Biochemistry will create employability in Pathology labs		Students will get idea about role of biomolecules essential for cellular reactions and physiological significance of anabolic and catabolic pathways used to drive cellular functions.	2017-18
3	Microbial Physiology	P-MIP-136	Students can get jobs as technician in different labs		Students will get thorough knowledge and understanding of core concepts of microbiology. Students will also get familiar with microbe	2017-18

					handling techniques	
4	Bioinstrumentation and Biostatistics	P-BIB-137	Student understands the Proper handling of instrument, which is essential in Research and Industry job.		Student develops the skill of instrument handling, Data analysis	2017-18
5	Molecular Biology	P-MOB-232	help in getting absorb in various research organization, molecular labs and industry research and development sector			2017-18
6	Immunology and immunotechniques	P-IMI-233	Expertise in immunological techniques will create employability in Pathology labs and Research Institutes		Student will be skilled in Immunotechniques	2017-18
7	Animal Biotechnology	P-ANB-234	Expertise in Cell line development, Vaccine Production using animal cell culture		Skills in Cell culture Techniques and its applications	2017-18

8	Bioprocess Engineering	P-BIE-235	Students will get job in Fermentation Industries as process design engineer.	Students can establish their own Industry	They learn Kinetics, Process designing etc.	2017-18
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