Rajarshi Shahu Mahavidyalaya (Autonomous), Latur

Department of Biotechnology

CHOICE BASED CREDIT SYSTEM (CBCS)

SEMESTER PATTERN

(w.e.f. Academic Year 2021-22)

SYLLABUS FOR

M.Sc. I 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 has a strong recommendation for Job oriented syllabus is 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

- 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 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 (Autonomous)
Department of Biotechnology
Choice Based Credit System
Course Structure of M.Sc. Biotechnology First Year (w.e.f. June 2021)

M. Sc. I [Biotechnology] Semester I

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

M.Sc. I [Biotechnology] Semester II

Code No.	Title of the course	Hours/ Week	Marks (100)		Credits
			In Sem	End Sem	
P-MOB-232	**Molecular Biology-V**	04	40	60	04
P-IMI-233	**Immunology and Immuno-techniques-VI**	04	40	60	04
P-ANB-234	**Animal Biotechnology-VII**	04	40	60	04
P-BIE-235	**Bioprocess Engineering-VIII**	04	40	60	04
P-LAC-236	**Lab Course V**	04	20	30	04
P-LAC-237	**Lab Course VI**	04	20	30	02
P-LAC-238	**Lab Course VII**	04	20	30	02
P-LAC-239	**Lab Course VIII**	04	20	30	02
P-SEM-240	**Seminar**	O3		50	02
	Total Credits				26

Rajarshi Shahu Mahavidyalaya (Autonomous), Latur
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:

- Students will understand the structures and purposes of basic components of cells and its reproduction.
- They will know the communication as well as transportation in cells. It will give an idea about how a cell becomes different from other.
- This syllabus will also help in understanding the biochemistry and molecular biology of cancer.

Course Outcomes:

- Describe levels of organization and related functions in plants and animals.
- Identify the characteristics and basic needs of living organisms and ecosystems.
- Explain the processes of growth and development in individuals and populations.
- Design and critically assess the scientific investigations they perform.
- Demonstrate critical thinking skills.

Unit I: **(15 L)**

Cell Introduction

Cell as the basic unit of life, History & Evolution, Salient features of cell.

Prokaryotes vs eukaryotes, Plant cell vs Animal cell.

Scheilden & 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: **(15 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: **(15 L)**

Cell signaling

Cell Signaling: Introduction, Stages of cell signaling.

Signal transduction: Concept, Factors determining signal transduction pathways.

Signal amplification process.

Cell receptors: Introduction and Types of receptors.

Second messengers: Introduction & classes of second messengers.

G - proteins in signal transduction.

Unit IV: **(15 L)**

Cell Cycle

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

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

Molecular basis of cancer: Cancer critical genes; proto-oncogenes, tumor suppressor genes, carcinogen, oncovirus.

Therapeutic interventions of uncontrolled cell growth.

Text and References:

1. Cell and Molecular biology- Jones & Bartlett Publishers David Sadava;
2. Cell & molecular biology - Gerald karp: John Wills
3. Molecular Biology of the Cell- Alberts, B –Garland Science
4. Molecular cell Biology - Darnell, Lodish, Baltimore, -W.H. Freeman
5. Cell biology- Cooper and Hausmann
6. Reproduction in Eukaryotic cells- DM Prescott, Academic Press.
7. Cell in Developmental and Inheritance- EB Wilson, MacMilan New York.
8. Fertilization-F T logo-Chapman and Hall
9. Molecular Biology of Steroid and Nuclear Hormone Receptors- LP Freedman,
10. Molecular Cloning: a Laboratory Manual- J. Sambrook, -CSHL Press,
11. Genomes – Garland ScienceT.A.–Brown

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

Course Title: Lab Course I **Course Code: P-LAC-138**
Marks: 50 **Credit:02**

Learning Objectives:

- Students will understand the structures and purposes of basic components of cells and its reproduction.
- They will know the communication as well as transportation in cells. It will give an idea about how a cell becomes different from other.
- This syllabus will also help in understanding the biochemistry and molecular biology of cancer.

Course Outcomes:

- Discuss the principles of the techniques by which subcellular components of mammalian cells can be isolated, how their presence can be verified experimentally, and how such techniques may be utilised in research or diagnostics
- Identify and describe / draw 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, analyse 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 of genetic disorders and normal.
7. Isolation of chloroplast.
8. Analysis of chlorophyll amount by Spectrophotometer.
9. Isolation & vital staining of Mitochondria.
10. Vital staining of lipid and glycogen bodies.
11. Cell types of plants- Microtomy/ maceration of various tissue explants and identification.
12. Buccal smear- Identification of Barr body.

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

Course Title: Biochemistry **Course Code: P-BIO-135**
Marks: 100 **Lectures: 60** **Credit: 04**

Learning Objectives:

- The course aims to provide students with a basic understanding of:
- Fundamentals of structures and interactions present in various biomolecules that help in functioning and organization of living cell.
- Biochemical pathways for synthesis and breakdown of complex biomolecules and metabolic disorders arise out of malfunction of metabolic pathways.

Course Outcomes:

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: **(15 L)**

Atoms and Thermodynamics

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

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.

Unit II: **(15 L)**

Carbohydrate

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: **(15 L)**

Metabolism

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: **(15 L)**

Molecular structure

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.

Test and References:

13. Principles of Biochemistry 4th edition Pub.WH Freeman Co. Nelson, D.L., Cox, M.M. Lehninger. (2004).
14. Biochemistry 4th Edn. W.H. Freeman and Co. NY. Stryer, L.
15. Biochemistry 2nd Edn. Voet, D., Voet J.G. (2004).
16. Principles of Biochemistry WmC Brown publishers. Oxford Zubey, G.L. Parson, W.W., Vance, D.E. (1994).
17. Fundamentals of Biochemistry, S. Chand and Company Ltd. (2005). Jain, J.L., Jain, S. and Jain, N.,
18. Outlines of Biochemistry: Conn and Stumpf
19. An Introduction to Practical Biochemistry, Tata McGraw-Hill Publishing Company Limited (1988) Plummer DT
20. Outlines of Biochemistry 2nd edition Pub: Tata. Kuchel, P.W., Ralston Schaums, G.B.
21. Biochemistry and Molecular Biology 3rd Indian edition, Pub.Oxford. Elliott, W.H., Elliott, D.C.

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

Course Title: Lab course II **Course Code: P-LAC-139**
Marks: 50 **Credit: 02**

Learning Objectives:
The course aims to provide students with a basic understanding of:

- Fundamentals of structures and interactions present in various biomolecules that help in functioning and organization of living cell.
- Biochemical pathways for synthesis and breakdown of complex biomolecules and metabolic disorders arise out of malfunction of metabolic pathways.

Course Outcomes:

- Students will able to estimate the concentration of proteins, lipids, nucleic acids, and carbohydrates
- Students will use current biochemical techniques to plan and carry out experiments.
- They will develop skills in isolation and identification of Proteins- SDS PAGE and NATIVE PAGE.

Practicals:

1. Preparation of Standard solutions

2. Preparation of buffers

3. Thin layer chromatography: lipids, mixture of dyes.

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 (Autonomous), Latur

M.Sc. Biotechnology (Semester Pattern)
I Semester

Course Title: Microbial Physiology **Course Code: P-MIP-136**
Marks: 100 **Lectures: 60** **Credit: 04**

Learning Objectives:

- The Master study program "Microbiology" builds consecutively on a biological education and is focused on research.
- A good scientific basic education in a Bachelor study program (normally in biology), enables enrolled students in the Master program to independent scientific work in a modern interdisciplinary scientific field.
- The study program is especially dedicated to the integration and consolidation of knowledge in microbiology.

Course Outcomes:

- Upon graduation, Microbiology majors should have a thorough knowledge and understanding of the core_concepts in the discipline of Microbiology. Microbiology students will be able to:

- Explain why microorganisms are ***ubiquitousin nature***; inhabiting a multitude of habitats and occupying a wide range of ecological habitats.
- Cite examples of the ***vital role*** of microorganisms in biotechnology, fermentation, medicine, and other industries important to human wellbeing.
- Demonstrate that microorganisms have an ***indispensable role*** in the environment, including elemental cycles, biodegradation, etc.

Unit I: **(15 L)**

Knowing microbial world:

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.

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, Chlamydias and Mycoplasma.

Archaea: Halophiles, Methanogens, Thermoplasma, Ferroplasmaand Hyperthermophilic archaea.

Eukarya: Algae, Fungi, Slime moulds and Protozoa.

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

Unit II: (15 L)

Pure Culture Techniques

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: (15 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: (15 L)

Metabolism

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

Text and References:

1. General Microbiology, Stainer. R.Y., Ingraham, J.I,.,Wheelis, M.L. and Painter, P. R. The MacMillan Press Ltd.
2. Brock, Biology of Microorganisms, Madigan, M.T..Martinko. J.M. and Parker, J. Prentice- Hall.
3. Microbiology, Pelczar, M.J. Jr., Chan, E.C.S. and Kreig, N.R., Tata McGraw Hill.

4. Microbial Genetics, Maloy, S.R., Cronan, J.E. Jr. and Freitelder, D. Jones, Bartlett Publishers.
5. Microbiology - A Laboratory Manual, Cappuccino, J.G. and Sherman, N. Addison Wesley.
6. Microbiological Applications, (A Laboratory Manual in General Microbiology) Benson, H.J. WCB: Wm C. Brown Publishers.

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

Course Title: Lab Course III **Course Code: P-LAC-140**
Marks: 50 **Credit: 02**

Learning Objectives:

- The Master study program "Microbiology" builds consecutively on a biological education and is focussed on research.
- A good scientific basic education in a Bachelor study program (normally in biology), enables enrolled students in the Master program to independent scientific work in a modern interdisciplinary scientific field.
- The study program is especially dedicated to the integration and consolidation of knowledge in microbiology.

Course Outcomes:

- Identify the various physiological groups of bacteria/archaea with their special features, their applications and ways to study them
- Students will learn to isolate pure cultures.

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. Growth: Growth curve.
5. Measurement of bacterial population by turbidometry and serial dilution methods.
6. Effect of temperature, pH and carbon and nitrogen sources on growth.
7. Microscopic examination of bacteria, yeast and molds and study of organisms by Monochrome stain, Negative Stain, Gram stain and staining for spores.
8. Assay of antibiotics.
9. Analysis of water for portability and determination of MPN.
10. Biochemical characterization of selected microbes.

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

Course Title: Bioinstrumentation and Biostatistics Course Code: P-BIB-137

Marks: 100 Lectures: 60 Credit: 04

Learning Objective:

- The course involves a working understanding of tools of technical skills in the field of Biology.
- The course involves conceptual understanding of bioinstrumentation.

Course Outcome:

- Select from, use and interpret results of, descriptive statistical methods effectively;
- Demonstrate an understanding of the central concepts of modern statistical theory and their probabilistic foundation;
- Select from, use, and interpret results of, the principal methods of statistical inference and design
- Communicate the results of statistical analyses accurately and effectively;
- Make appropriate use of statistical software.
- Read and learn new statistical procedures independently

Unit-I **(15 L)**

Microscope

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)**

Chromatography

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: **(10 L)**

Spectroscopic techniques:

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 dichorism spectroscopy, Atomic spectroscopy. Lasers, Spectrofluorimetry, Luminometry, turbidometry and nephelometry.

Unit-IV: **(10 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.

Text and References:

1. Keith Wilson and John Walker. Practical Biochemistry- principles and techniques; Cambridge University press, London, UK.(Fifth edition).
2. Biophysical chemistry: Principles and Techniques; Himalaya Publishing House, Upadhyay, Upadhyay and Nath.
3. David T Plummer, Tata McGraw- Hill publishing company limited; McGrqw office, New Delhi.
4. A Biologist's guide to principle and techniques of practical biochemistry - Brigan L. Williams.
5. Handbook of Biomedical Instrumentation - R.S. Khandpur, Tata McGraw Hill
6. Biophysics - Cotrell (Eastern Economy Edition)
   Clinical Biophysics –Principles and Techniques- P. Narayanan (BhalaniPub.,Mumbai)
7. Biophysics – Pattabhi and Gautham (Narosa Publishing House)
8. Instrumentation measurements and analysis – Nakara, Choudhari (Tata Mc Graw Hill)
9. Handbook of analytical instruments – R.S. Khandpur (Tata Mc Graw Hill)

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

Course Title: Lab Course IV **Course Code: P-LAC-141**
Marks: 50 **Credit: 02**

Learning Objective:

- The course involves a working understanding of tools of technical skills in the field of Biology.
- The course involves hands on approach for instrumentation.

Course Outcome:

On completion of course students are able to understand

- Verification of Beer's law
- Determination of lambda max by using a suitable dye •
- Separation of Compounds by chromatography
- Demonstration of agarose gel electrophoresis, SDS and NATIVE PAGE
- Demonstration of ELISA
- Construct simple statistical hypothesis and composite statistical hypothesis
- Determine probability of the error of first kind and second kind
- Test null hypothesis against the alternative hypothesis

Pracicals

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 Chromatography HPLC
7. Electrophoresis Of DNA
8. Electrophoresis of proteins under native and denaturing conditions (PAGE)
9. To find out isoelectric point of amino acid

10. Western blotting
11. ELISA
12. Study of Lambert's & Beer's law
13. Absorption spectrum of protein
14. Problems based on Spectroscopy
15. Problems based on Radioactivity
16. Problems based on Biostatistics

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

Course Title: Molecular Biology **Course Code: P-MOB-232**
Marks: 100 **Lectures: 60** **Credit: 04**

Learning Objective:

- To understand core aspects of molecular biology from basics to advanced.
- To know Scope and achieve molecular biology study skills theoretically and practically.

Course Outcomes:

- Understand the synthesis, structure, and function of nucleic acids and proteins in prokaryotes and eukaryotes.
- Understand the principles of inheritance from molecular mechanisms to population consequences.
- Understand the flow of genetic information in populations and the relationship between genetics and evolutionary theory.

Unit I **(15 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 **(15 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 **(15 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 **(15 L)**

Basic concepts of developmental biology (molecular insight):-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.

Text and References:

1. Concepts of genetics- William S. Klug and Michael R. Cummins
2. Genome- T.A. Brown, John Wiley
3. Molecular Biology of the Cell VI ed.-Lodish, Berk-Freeman Pub.
4. Developmental Biology V ed.-Scott F. Gilbert-Sinahauer associate Pub.
5. Genetics: A conceptual Approach; Benjamin A. Pierce.
6. Developmental genetics-G.S.Miglani-I.K.InternationalPub.
7. Molecular Biology of the Cell, Albert Bruce, Garland Science Publication.
8. Genetics a Molecular Approach, T.A Brown, John Wiley

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

Course Title: Lab course V **Course Code: P-LAC-236**
Marks: 50 **Credit: 02**

Learning Objective:

- To understand core aspects of molecular biology from basics to advanced.
- To know Scope and achieve molecular biology study skills theoretically and practically.

Course Outcomes:

- Students are able to develop skills in isolation and purification of genomic DNA, RNA and plasmid DNA.
- Skills in Transformation Conjugation and Transduction Techniques.

Practicals:

1. Genetic recombination (conjugation, transformation,tranduction) 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. In vitro transcription and translate
11. Isolation of RNAs

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

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

Learning Objective:

- The course involves a basic understanding of principles of immunology and its technical aspects in the field of Immunology.
- To study cellular interactions and activation of immune cells.
- To Study all about antigen and antibody interactions.

Course Outcome:

- The basic replication strategies of viruses and the fundamentals of interactions between viruses and the host;
- The role and importance of innate and adaptive immunity to host defense against micro-organisms;
- The functions and properties of different cell types and organs that comprise the immune system;
- The cellular interactions and activation of immune cells in response to foreign antigen and cytokines;
- Antibody structure and how this relates to antibody functions;

Unit I **(15 L)**

Introduction

The origin of immunology, Innate and Adaptive Immune response.

Hematopoiesis, 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.

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 **(15 L)**

Vaccine 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.

Text and References:

1. Kuby Immunology. Goldsby, Kindt, Osborne. 4th ed.W,H Freeman & Company, New York
2. Kuby Immunology. Goldsby, Kindt, Osborne. 6th ed.W,H Freeman &Company,New York.
3. Cellular & Molecular Immunology. Abbas, Lichtman, Pillai. 6th ed. Elsevier publications.
4. Roitt's Essential Immunology. Deives, Martin, Burton, Roitt. 11th ed. Blackwell publications.
5. Cellular interactions &Immunobiology. Butterwort & Heinemann.
6. Review of Medical Microbiology & Immunology. Warren Levinson. 9thed.Mac Graw Hill publications.
7. Immunology an introduction. Tizard.4th ed. Thomson publications.
8. Immunology. B, Hannigan. Viva books Pvt. Ltd.
9. Immunology & Serology. K.R.Joshi, N.O. Osamo. Student edition.

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

Course Title: Lab course VI **Course Code: P-LAC-237**
Marks: 50 **Credit: 02**

Learning Objective:

- The course involves a basic understanding of principles of immunology and its technical aspects in the field of Immunology.
- To study reactions take place in blood.

Course Outcome:

Students are able to understand:

- Concept of antigen, antigenic determinants,
- Immunoglobulin, structure, types and functions,
- Immuno-techniques like RIA, ELISA, Rocket Immuno-electrophoresis etc.

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 (Autonomous), Latur
M.Sc. Biotechnology (Semester Pattern)
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.
- Understand and discuss the social and ethical issues associated with biotechnology.

Course Outcome:

- Student understood fundamentals Animal cell Science.
- Development of Laboratory Skills about animal cell science.
- Understanding of application of animal cell science in Biotechnology.
- Development of Research oriented aptitude.

Unit I: **(15 L)**

Instruments

Planning, construction and services; Layout; Sterile handling area; Incubation; Hot room; Air circulation; Service bench; Laminar flow; Sterilizer; Incubator; CO_2 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

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 **(10 L)**

Animal Cell Culture

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: **(10 L)**

Applications

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: **(10 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; Multiarray disks, spirals and tubes; Roller culture; Microcarriers; Perfused monolayer cultures; Membrane perfusion; Hollow fiber perfusion; Matrix perfusion; Microencapsulation; Growth monitoring

Text and References:

1. Culture of Animal Cells, 5th Edition, Wiley-Liss, 2005 Freshney
2. Animal Cell Culture - Practical Approach, 3rd Edition, Oxford University Press, 2000. Ed. John R.W. Masters
3. Animal Cell Culture Techniques. Springer, 1998 Ed. Martin Clynes

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

Course Outcome:

- The students would be well aware about basic infrastructure and culture technique of ATC.
- Students will learn to handle cell line History, scope, principle, merits and demerits of animal cell and tissue culture.
- Application of animal cell and tissue culture, biohazards and Biosafety.

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 (Autonomous), Latur
M.Sc. Biotechnology (Semester Pattern)
II Semester

Course Title: Bioprocess Engineering **Course Code: P-BIE-235**
Marks: 100 **Lectures: 60** **Credit: 04**

Learning Objective:

- The course involves a working understanding of tools of design of fermenters, Engineering calculations, Growth kinetics and process kinetics.
- To study the basic equations in bioprocess engineering.

Course Outcome:

- After completing this course, the student 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.
- The student will be able to evaluate the cultivation, enrichment and growth prevention methods for microbes.
- The student will be able to explain the roles of microbes in elemental cycles on Earth and, the waste decontamination methods based on microbial activities.
- He/she will be able to judge how microbes and enzymes could be applied in industry.

Unit I: **(15 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: **(15 L)**

Fermenters

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 depth of microbes and equipments used in sterilization: Batch & Continuous Quality Control, Quality assurance, Standard Operating Procedures (SOP) & Good Manufacturing Practices (GMP)

Unit III: **(15 L)**

Media for large-scale processes & their optimization

Constituents of media, their estimation & quantification. Design of media. Costing of media.

Isolation, Screening, Preservations and maintenance of Microorganisms, strain improvement, Mutagenesis, Genetic Engineering for Strain Improvement. Development of inocula

Types of Bioprocesses: Biotransformations (enzyme, whole cell), Batch, Fed-batch, Cell recycle & continuous fermentation processes. Monod model & constitutive equations used for expressing growth, substrate consumption & product formation, Solid State fermentation

Unit IV: **(15L)**

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, fixes & variable cost, Depreciation, Amortized costs, Selection of Pricing, Profitability, Scales of operations etc.

Text and References:

1. Principles of Fermentation Technology - Whittaker & Stan bury, Pergamon Press
2. Bioprocess Engineering Principles - Pauline Doran, Academic Press 1995
3. Operational Modes of Bioreactors, BIOTOL series - Butter worth, Heinemann 1992
4. Bioreactor Design & Product Yield, BIOTOL series - Butter worth Heinemann 1992
5. Bioprocess Engineering: Systems, Equipment & Facilities - Ed. B. Lydersen, N.A. Delia & K.M. Nelson, John Wiley & Sons Inc,1993
6. Bioseparation & Bioprocessing - Ed. G. Subramaniam, Wiley –VCH,1998
7. Product Recovery in Bioprocess Technology, 'BIOTOL series, Butter worth Heinemann 1992
8. Bioseparation: Downstream Processing for Biotechnology - Paul A. Belter, E.L Cussler, Wei-Shou Hu, Academic Press
9. Solvent Extraction in Biotechnology - LarlSchuger, SpingerVerlag, 1994
10. Basic Biotechnology 3rd edition Colin Ratledge – Cambridge Publication
11. Fundamentals of Biochemical Engineering 2nd edition Bailay&ollis- TataMcGraw Hill Publication
12. Basic of Bioprocess Engg. Shuler and Kargil
13. Compressive Biotechnology Vol III Mooyoung Elsevier Publication
14. Introduction to Industrial microbiology, Cruger-ACS Publication
15. Industrial microbiology- Casida- ACS Publication

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

Course Title: Lab course VIII **Course Code: P-LAC-239**
Marks: 50 **Credit: 02**

Learning Objective:

- The course involves a working understanding of tools of design of fermenters
- To Understand Engineering calculations, Growth kinetics and process kinetics.

Course Outcome:

Students are able to understand:

- Bioprocess engineering, mutagenesis, protoplast fusion techniques for strain improvement of primary and secondary metabolite.
- Upstream and Downstream processing.

Practicals:

1. Media formulation and optimization
2. Study of Growth Kinetics of Bacteria and Yeast by turbidometry& SCP
3. Screening and maintenance of Industrially important microorganism- Acids, Antibiotics, Enzymes.
4. Study of scale up of fermentation
5. Study of design of bioreactor
6. Determination of TDP
7. Determination of TDT and design of sterilizer
8. Study of types of fermentation process (Surface and submerged)
9. Downstream process of industrial products (Intra & Extra cellular)
10. Problems based on: - Growth kinetics, fluid flow, Reynold's number
11. 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.

Sr. No.	Cross Cutting Issues	Related course
1.	**Gender Sensitization**	_
2.	**Environment & Sustainability**	Animal Biotechnology Microbial Physiology
3.	**Human Values**	_
4.	**Professional Ethics**	Bioprocess Engineering

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