



**Parvatibai Chowgule College of Arts and Science**  
**Autonomous**

Accredited by NAAC with Grade 'A' (CGPA Score 3.41 on a 4 Point Scale in 3rd cycle)  
Best affiliated College-Goa University Silver Jubilee Year Award

**Learning Outcomes based Curriculum Framework (LOCF)**

**for**

**Biotechnology (Single Major)**

**Undergraduate Programme**

**2020**

## **1. Preamble**

The learning outcomes are designed to help learners understand the objectives of studying B.Sc. Biotechnology that is, to analyse, appreciate, understand the use of living systems and organisms to develop or make products which enable them to understand the various perspectives of applied sciences that benefit the mankind. The organization of the courses under CBCS are divided into semesters/years keeping in consideration the credit load in a given semester with the ultimate end of outcomes of the course/programme. However, it makes sense to include courses/papers that demand more attention in the second and third years of the B.Sc. Biotechnology course.

## **2. Introduction**

Biotechnology is the amalgamation of biology and technology and is a fast-growing and evolving field in science. The recent development in the field of Biotechnology has resulted in a rapid growth and establishment of biotechnological industries. This has resulted in great demand for trained manpower in this field and has opened new career opportunities for the young generation of the state. To cater to this need, the College has started the degree programme B.Sc. Biotechnology in 2008. Since its recent establishment, the department is functioning efficiently with the help of well-established laboratory and hardworking staff.

## **3. Objectives of B.Sc. Biotechnology Programme**

The overall objectives of B.Sc. Biotechnology programme are to provide students with Core courses in Biochemistry, Microbiology, Cell and Molecular Biology, Genetics and Genetic Engineering, Immunology and Industrial Biotechnology and the Elective courses in Molecular Genetics, Plant and Animal diversity, physiology and Cell culture, Biostatistics and Bioinformatics. Also, each course has a practical component where students gain hands-on experience of experiments based on concepts learned in theory. Online resources are made available through “CLAAP/ Google class room.” The students also offered with compulsory internship programme where students work for a minimum of 120 hours with pathology laboratories, pharma/biopharmaceutical companies and research institutes. In addition to regular lectures, we also organize guest lectures on the latest developments in Biotechnology. As part of this course, students undertake a six-month project which they are encouraged to present at National Seminars and to further publish their data in peer-reviewed journals. The department endeavours to provide a theoretical backbone as we expect our students to be able to apply these concepts thereby developing analytical skills. We want students who are highly motivated to learn new concepts, comfortable in a laboratory setting and most importantly, who have a patient disposition.

#### **4. Overview of Department**

There are 5 full-time well qualified experienced faculty having expertise in various fields of biotechnology such as, Microbiology, Immunology, Molecular Biology, Biochemistry, Genetic Engineering, Industrial Biotechnology, Bioinformatics, Plant and Animal cell culture, etc.

The department has well equipped laboratories with sophisticated instruments such as autoclave, BOD Incubators, Hot Air Oven, Bacteriological Incubators, Microscopes, , Inverted Microscope, Laminar Air Flow, Growth chamber, CO<sub>2</sub> Incubator, Vortex Mixers, Water Bath Shaker, Deep Freezer, Spectrophotometer, Vertical and Horizontal Slab Gel System, UV Transilluminator, pH Meter, Centrifuge, Water distillation unit, Small scale fermenter, etc.

The department organizes various workshops, seminar, guest lectures in subject specific domains to enrich our students with recent developments in the field of Biotechnology. We also, organize annual inter-collegiate event 'Synapse' which helps students develop their organizational as well as leadership qualities. There is a Biotechnology club – Biochrome that organizes fun-learning activities for Biotechnology students to apply their knowledge in various activities related to their subject and enhance their critical thinking abilities. Biochrome also invites Alumni of the department every year to orient the present students with the scope in the field of Biotechnology and share their experiences about their career progression.

Over the years, after completion of B.Sc. Biotechnology course our students pursue higher education in foreign universities such as, Masters in Molecular Medicine at University of Sheffield, United Kingdom; Masters in Biomedical Science at National University of Ireland, Ireland; Masters in Biomaterials and Tissue Engineering at University College London, UK; Masters in Sustainable Food Management at ISA Ille Lille University at France; Masters in Sustainable Environment Management at University in Poland; Masters in Molecular Biology at Vrije University, Brussels; Masters in Cancer Therapy at University of Strathclyde in Glasgow, Scotland; Masters in Medical Biotechnology at Windsor University, Canada; Masters in Engineering, Food Technology and Management, Lille Catholic University, France; Masters in Forensic Science in Scotland. The department has also been credited with a student being awarded with British Council Scholarship in Masters in Biotechnology at the University of Edinburgh, Scotland. Also, most of our students have pursued their Masters in Biotechnology from VIT, Vellore; Goa University; Symbiosis Institute, Pune; Bhartiya Vidyapeeth Institute, Pune; D. Y. Patil University; Kolhapur and carrying out PhD at Jawaharlal Nehru Centre for Advance Scientific Research, Bangalore; Tata Institute of Fundamental Research, Mumbai, etc.

## **5. Graduate Attributes**

Program Learning Outcomes	Short Title of the PLOs	Description of the Program Learning Outcomes Graduates will be able to;
PLO 1	Problem Analysis and Use of Technology	Think critically, identify, analyze problems/ situations and further attempt to design/ develop solutions that meet the specified goals. Apply appropriate IT tools efficiently in their daily activities of communication and academics.
PLO 2	Environmental sustainability and Ethics	Analyze and attempt solutions to environmental issues and commit themselves to sustainable development in the local/ national and global context. Recognize and understand professional ethics /human values and be responsible for the same.
PLO 3	Individual and Team work, communication and life skills	Function effectively at various levels, capacities and situations. Communicate proficiently (oral and written) as a responsible member of society.
PLO 4	Research Aptitude and Social responsibility	Understand general research methods and be able to analyze, interpret and derive rational conclusions. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of domain specific change.
PLO 5	Critical thinking, Analysis and Problem Solving	Demonstrate proficiency in quantitative reasoning (critical thinking) and analytical skills. Also, be able to use these skills to analyze and solve industry related problems, thus preparing them for a successful career in industry and research institutes.
PLO 6	Understanding the need for sustainable solutions	Be able to understand the need and impact of biotechnological solutions on environment and societal context, keeping in view the need for sustainable solutions.
PLO 7	Development of practical skills	Equipped with practical skills and the ability to apply their theoretical concepts to design, perform experiments, analyze and interpret data and thus develop proficiency in laboratory management.
PLO 8	Developing an inclination towards research	Develop an inclination towards research through the compulsory internship in industry/research/academic institutes which promote and inculcate professional ethics and code of practice among students, enabling them to work in a team with a multidisciplinary approach.

## **6. Qualification descriptors**

The key qualification descriptor for undergraduate Biotechnology shall be clarity of concepts, experimentation, critical thinking and ethical awareness. The students of biotechnology will be able to demonstrate systematic approach to the experimental and theoretical aspects; expand the

knowledge of the subject from the classroom/laboratory to industry and society as they will be able to recognize the scope of Biotechnology in terms of career opportunities.

The courses such as Microbiology, Biomolecules, Cell biology and Genetics, Basics of plant and animal sciences, Immunology, Molecular Biology, Genetic engineering will enrich students with conceptual knowledge. The courses such as Tools and techniques in Biotechnology, Food and Environmental Biotechnology, Plant and Animal Biotechnology, Industrial Biotechnology and Bioinformatics includes understanding of fundamentals, acquiring practical training and application of the subject knowledge in diversified areas of Biotechnology with a clear understanding that this knowledge will equip the students to make them suitable for various Biotech, Pharma, Medicine, Agri-Biotech, Biochemical related laboratories/industries. The courses such as Biostatistics, Molecular genetics and Molecular medicine will enable a student in having a critical thinking approach towards the various fields of biotechnology. Bioethics and Biosafety course encompass the ethical awareness amongst the students related the various fields in biotechnology.

#### **7. Programme Learning Outcome (PLOs)**

After successful completion of a Bachelor's degree in Biotechnology, the students will be able to;		
<b>PLO 1</b>	Critical thinking, Analysis and Problem Solving	Demonstrate proficiency in quantitative reasoning (critical thinking) and analytical skills. Also, be able to use these skills to analyze and solve industry related problems, thus preparing them for a successful career in industry and research institutes.
<b>PLO 2</b>	Understanding the need for sustainable solutions	Be able to understand the need and impact of biotechnological solutions on environment and societal context, keeping in view the need for sustainable solutions.
<b>PLO 3</b>	Development of practical skills	Equipped with practical skills and the ability to apply their theoretical concepts to design, perform experiments, analyze and interpret data and thus develop proficiency in laboratory management.
<b>PLO 4</b>	Developing an inclination towards research	Develop an inclination towards research through the compulsory internship in industry/research/academic institutes which promote and inculcate professional ethics and code of practice among students, enabling them to work in a team with a multidisciplinary approach.

## 8. Course Structure

SEMESTER	CORE		ELECTIVE			
I	<b>BIO-I.C-1</b> Biomolecules	<b>BIO-I.C-2</b> Cell Biology	-----	-----	-----	-----
II	<b>BIO-II.C-3</b> Fundamental Genetics	<b>BIO-II.C-4</b> Basic Microbiology	-----	-----	-----	-----
III	<b>BIO-III.C-5</b> Molecular Biology		<b>BIO-III.E-1</b> Basics of Plant and Animal Sciences	<b>BIO-III.E-2</b> Metabolism of Biomolecules	<b>BIO-III.E-3</b> Biostatistics	<b>BIO-III.E-4</b> Enzymology
IV	<b>BIO-IV.C-6</b> Immunology		<b>BIO-IV.E-5</b> Plant and Animal Physiology	<b>BIO-IV.E-6</b> Tools & Techniques in Biotechnology	<b>BIO-IV.E-7</b> Evolution and Anthropology	<b>BIO-IV.E-8</b> Molecular genetics
V	<b>BIO-V.C-7</b> Concepts in Genetic Engineering		<b>BIO-V.E-9</b> Molecular medicine	<b>BIO-V.E-10</b> Environmental Biotechnology	<b>BIO-V.E-11</b> Plant Biotechnology	<b>BIO-V.E-12</b> Bioinformatics
VI	<b>BIO-VI.C-8</b> Industrial Biotechnology		<b>BIO-VI.E-13</b> Bioethics and Biosafety	<b>BIO-VI.E-14</b> Advanced Cell Biology	<b>BIO-VI.E-15</b> Food Biotechnology	<b>BIO-VI.E-16</b> Animal Cell Culture

- Generic Elective Course: Mushroom Cultivation and Vermicomposting

## 9. Course Description

### **Biomolecules**

This course provides basic foundation on bio-molecules of life with reference to their properties, and biological functions. The course also provides detailed knowledge on how cellular structure and function arise as a result of the properties of cellular macromolecules.

### **Cell Biology**

This course will give a detailed description of the organization of the cell, the structure and functions of various organelles. The course also focuses on the communication cells and the importance of cell division

### **Fundamental Genetics**

Genetics allows for the understanding of the structure and function of genes and chromosomes as well as the harmful effects of mutations which can cause various genetic disorders.

### **Basic Microbiology**

The main aim of this course is to introduce the students to the vast world of Microbiology. This course covers a range of topics in Basic Microbiology from the historical perspective to structure, composition of microbes, their interactions with the environment and their impact on the humans.

### **Molecular Biology**

This course provides insights on replication, transcription and translation process in prokaryotes and eukaryotes, various mutations and their repair mechanisms, regulation of gene expression and mechanism of gene transfer.

### **Basics of Plant and Animal Sciences**

This course provides insights on the Plant and Animal Kingdoms and their classification into different phyla. They will understand the variety of habitats that support the growth and reproduction of different plants and animals and will also look into the general characteristics and adaptations exhibited by these organisms.

### **Metabolism of Bio-molecules**

While the core courses in Bio-molecules explored the different bio-molecules, their structure and function, these elective aims to provide clarity to those basics by integrating the processes of metabolism and observing their function under different conditions.

### **Biostatistics**

The objective of this course is to introduce students to statistical methods and to understand the underlying principles (summarizing data and drawing valid inferences based on the limited information). The purpose of the course is to give students an introduction to the discipline, an appreciation of a statistical perspective on information from biology and basic critical skills to assess the quality of research evidence.

### **Enzymology**

This course will provide a comprehensive view of enzyme chemistry and kinetics, methods and strategies for enzyme purification and characterization. One section also deals with the applications of enzymes in diagnostics.

### **Immunology**

This course aims at introducing the basic concepts of the immune system and its defence mechanisms. This will help them understand and reason out concepts related to diseases. A section on vaccination, monoclonal and polyclonal antibodies stresses on the importance of these for treatment of lethal diseases.

### **Plant and Animal Physiology**

The main aim of this course is to introduce the students to the physiology of plant and animal systems with special emphasis on humans, thereby allowing them to understand how plant and animal systems function.

### **Tools and Techniques in Biotechnology**

This course aims at introducing the importance of the basic concepts of instruments and their applications in the field of biotechnology.

### **Evolution and Anthropology**

This course aims at introducing the importance of the basic concepts of Evolution and anthropology and its importance in the field of biotechnology which will increase the awareness of the principles of human evolution and the biological adaptations that humans have made through time to various biotic and abiotic factors.

### **Molecular genetics**

Having completed the two prerequisite courses - Fundamental Genetics and Molecular Biology, students will be able to apply their knowledge and skills to this course. It focuses on various aspects of human genetics and explores the techniques and tools at the molecular level that can be used to identify them.

### **Concepts in Genetic Engineering**

The course aims to introduce the students to the principles and techniques involved in Genetic Engineering through the use of genetic material and cloning vehicles for suitable manipulation of genes.

### **Molecular medicine**

This course is the application of molecular biology and molecular genetics to the understanding of human health and disease. It aims to understand the underlying origins and mechanisms of human diseases and to find novel ways of preventing, diagnosing and treating diseases

### **Environmental Biotechnology**

The main aim of this course is to introduce the students to the hazards of our environment, the effects of pollution on living systems, solutions to protect the environment for sustainable development.

### **Plant Biotechnology**

This course aims at introducing the concept of in vitro culture of plants including set up of a plant tissue culture laboratory, instruments and sterilization techniques. This course will help the students to understand that various parts of the plant may be cultured, with each type of culture having specific applications. Plant tissue culture also lends itself for production of transgenic plants which have various applications.

### **Bioinformatics**

This course aims at introducing the importance of the basics of computers, concept of Human Genome Project, storage of biological information, tools and techniques of bioinformatics used and their importance in the field of biotechnology.

### **Industrial Biotechnology**

The course covers basic concepts in Industrial Biotechnology, mainly introducing the basics of upstream processes in fermentation technology on an industrial scale.



### **Bioethics and Bio-safety**

This course aims at introducing the importance of the basic concepts of bioethics and biosafety and their relationship with several fields such as ecology, agriculture, medicine, chemistry and advances brought about in the field of biology and medicine. The course deals with answers to ethical questions that arise in the relationships among life sciences and their importance in the field of biotechnology.

### **Advanced Cell Biology**

The course will give a detailed description of how eukaryotic cells receive, transmit and respond to environmental signals, cellular regulation of cell cycle progression and cell death. The principal and working of the essential tools used in cell biology will also be covered.

### **Food Biotechnology**

This course adds information about the role of microorganisms in many food industries both in production and spoilage processes and to understand the importance of the role of microorganisms in food industries in both beneficial and harmful ways.

### **Animal Cell Culture**

This course is designed to introduce the students to the basic concepts of Animal Cell Culture. The course covers topics that explain animal cell culturing and methods involved in basic culturing of animal cells with a few applications to life sciences.

## **10. Course Learning Objectives (CLOs)**

### **BIO-I.C-1: BIOMOLECULES**

On the successful completion of this course the students will be able to:

CLO1: Discuss the structure of atoms, biomolecules and chemical bonds.

CLO2: Understand concepts of enzyme kinetics, bio-polymers, metabolic reactions in a living system.

CLO3: Understand and apply general laboratory safety measures as well as calculate for preparation of various chemicals for experiments.

CLO4: Prepare different solutions such as buffers, reagents and stock solutions for experiments independently.

CLO5: Operate various lab instruments such as weighing balance, water bath and spectrophotometer.

### **BIO-I.C-2: CELL BIOLOGY**

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

CLO1: Correlate the function of each cell organelle with proper coordination.

CLO2: Demonstrate an understanding of cell communication.

CLO3: Prepare various plant and animal specimens for observation of cell structures

CLO4: Identify and analyse different biological cells using a compound microscope.

### **BIO-II.C-3: FUNDAMENTAL GENETICS**

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

CLO1: Outline the basic principles of Mendelian genetics and compare and analyze different inheritance patterns as well as solve problems based on genetic principles.

CLO2: Compare and contrast different mutations, their effects on cells and the application of the same to research.

CLO3: Differentiate between the structure and working of a compound and dissection microscope.

CLO4: Construct and interpret a karyotype prepared from a spread of metaphase chromosomes.

### **BIO-II.C-4: BASIC MICROBIOLOGY**

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

CLO1: Understand the scope and importance of Microbiology, classification schemes, cultivation, preservation and maintenance of microbial cultures.

CLO2: Discriminate between various groups of microorganisms and also comprehend the beneficial and harmful effects of each group of microorganisms.

CLO3: Compare, analyse and apply the concepts of the principle and working of various types of microscopes.

CLO4: Adhere to strict laboratory safety measures to be followed in a microbiology laboratory.

CLO5: Master skills in aseptic techniques as well comprehend the importance of cleaning and decontamination.

### **BIO-III.C-5: MOLECULAR BIOLOGY**

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

CLO1: Explain the structure of DNA and RNA.

CLO2: Understand basic concepts in molecular biology.

CLO3: Compare differences between replication, transcription and translation processes in prokaryotes and eukaryotes.

CLO4: Describe the mechanism of gene transfer and regulation.

CLO5: Isolate and purify genomic DNA.

### **BIO-III.E-1: BASICS OF PLANT AND ANIMAL SCIENCES**

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

CLO1: Explain classification of plant and animal kingdom.

CLO2: Distinguish between various phyla of the plant and animal kingdoms based on their characteristics.

CLO3: Compare and contrast the differences in morphology and anatomy in Angiosperms.

CLO4: Explain features of the non-chordates and chordates.

CLO5: Sketch the morphology and anatomy of selected plant and animal specimens.

### **BIO-III.E-2: METABOLISM OF BIOMOLECULES**

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

CLO1: Understand and explain the metabolic processes.

CLO2: Explain the interconnections of metabolic pathways.

CLO3: Explain the effect of diet on metabolism and implications of improper diet and metabolism.

CLO4: Estimate various biomolecules using spectrophotometry, Thin layer chromatography & centrifugation techniques.

CLO5: Understand and describe the causes and treatment of various metabolic disorders through case studies.

### **BIO-III.E-3: BIOSTATISTICS**

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

CLO1: Explain the importance of Biostatistics in biology.

CLO2: Understand the concepts of Sampling.

CLO3: Represent and interpret the data using graphical method and MS Excel

CLO4: Solve problems on measures of central tendency, dispersion and hypothesis testing.

CLO5: Apply appropriate statistical tools in their project work.

### **BIO-III.E-4: ENZYMOLOGY**

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

CLO1: Explain the structure of an enzyme and kinetics of enzyme catalysed reactions.

CLO2: Understand different types of enzyme inhibitions.

CLO3: Understand the wide applications of enzymes and future potential.

CLO4: Isolate and purify crude forms of enzyme extract and apply appropriate method for determination of activity of enzyme.

CLO5: Discuss factors that affect enzymatic activity.

### **BIO-IV.C-6: IMMUNOLOGY**

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

CLO1: Compare and contrast primary and secondary immune response.

CLO2: Gain knowledge of the structure and function of the cells and organs of immune systems.

CLO3: Describe the mechanisms of Ag-Ab reaction, hypersensitivity reactions and importance Complement system.

CLO4: Understand the importance of Monoclonal Ab and various immunodeficiency diseases.

CLO5: Familiarize with various techniques involved in Immunology.

### **BIO-IV.E-5: PLANT AND ANIMAL PHYSIOLOGY**

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

CLO1: Understand the physiological aspects of plants and animals.

CLO2: Explain the parts/organs and processes involved.

CLO3: Comprehend and distinguish between the organs and organs systems while understanding the biological functions associated with every system.

CLO4: Perform basic experiments like blood counts and checking pressure.

CLO5: Understand the effect of hormones on plant growth and assess the metabolites in the plant.

### **BIO-IV.E-6: TOOLS AND TECHNIQUES IN BIOTECHNOLOGY**

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

CLO1: Explain the principle, types of centrifugation and their functions in biological sciences.

CLO2: Understand the basic differences between agarose electrophoresis, SDS and native PAGE.

CLO3: Explain the principle and applications of various spectroscopic and chromatographic techniques.

CLO4: Discuss radioactivity, radioactivity techniques used in biomedical research.

CLO5: Perform purification and separation of proteins.

#### **BIO-IV.E-7: EVOLUTION AND ANTHROPOLOGY**

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

CLO1: Understand basic concepts of evolution and anthropology and importance in biotechnology.

CLO2: Explain the evolutionary history and describe the historical development of anthropology.

CLO3: Explain past and present cultures including ecological adaptations with scientific approach.

CLO4: Describe quantitative and qualitative methods in the analysis of anthropological data.

CLO5: Critically evaluate the logic of anthropological research and apply anthropological research to contemporary environmental, social, or health issues worldwide.

#### **BIO-IV.E-8: MOLECULAR GENETICS**

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

CLO1: Understand the concepts of chromosomes, cell division and its associated disorders.

CLO2: Understand the various molecular aspects of human genetics including DNA variation and mutations.

CLO3: Explain concepts in diagnosis of inherited diseases and forensics genetics.

CLO4: Discuss case studies on application of various molecular biology techniques for the diagnosis of genetic disorders.

CLO5: Calculate the risk factors in genetic counselling for individuals with a family history of genetic disorders through case studies.

#### **BIO-V.C-7: CONCEPTS IN GENETIC ENGINEERING**

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

CLO1: Understand the functions of several enzymes and vectors used in genetic engineering.

CLO2: Acquaint to the versatile tools and techniques employed in recombinant DNA technology.

CLO3: Explain the construction of DNA & c DNA library.

CLO4: Acquire skills on techniques of plasmid isolation.

CLO5: Develop skills for transformation and selection of recombinants.

#### **BIO-V.E-9 MOLECULAR MEDICINE**

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

CLO1: Understand the historical aspects of molecular medicine.

CLO2: Understand the underlying genetic factors of common diseases.

CLO3: Describe molecular and cellular therapies for the same.

CLO4: Gain a basic knowledge on cancer genetics and pharmaco-genetics.

CLO5: Understand the importance of maintaining public health.

#### **BIO-V.E-10: ENVIRONMENTAL BIOTECHNOLOGY**

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

CLO1: Explain the scope of Environmental Biotechnology.

CLO2: Understand basic ecological concepts, various pollution, its measurements & remediation.

CLO3: Describe the various eco-friendly bio-products.

CLO4: Assess quality of water sample through various parameters - MPN test, dissolved oxygen concentration, biological oxygen demand, chemical oxygen demand nitrates of water sample.

CLO5: Understand the working of sewage treatment plant.

### **BIO-V.E-11: PLANT BIOTECHNOLOGY**

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

CLO1: Understand that various parts of the plant that can be cultured, with each type of culture having specific applications.

CLO2: Comprehend concepts of protoplast culture, somatic hybridization and production of secondary metabolites.

CLO3: Describe genetic engineering methods for production of transgenic plants.

CLO4: Understand aspects of plant biotechnology like set up of laboratory, culture of explants.

CLO5: Perform techniques of root/shoot callus production and cell suspension culture.

### **BIO-V.E-12: BIOINFORMATICS**

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

CLO1: Explain the scope of Bioinformatics.

CLO2: Understand the basic concept of biological databases, various types and applications of biological databases.

CLO3: Describe the various applications of BLAST and FASTA in understanding differences in evolutionary patterns.

CLO4: Assess mutations, genetic disorders and understand the importance of drug design in silico.

CLO5: Will be able to construct evolution tree, cladogram, retrieve the biological information accessed through various information resources.

### **BIO-VI.C-8: INDUSTRIAL BIOTECHNOLOGY**

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

CLO1: Understand and explain various parts of a fermenter.

CLO2: Comprehend various concepts of Upstream and Downstream processes.

CLO3: Describe the production processes of fermentation products like wine or vinegar at the industrial level.

CLO4: Design small scale experiments to produce common enzymes like amylase.

CLO5: Prepare basic fermentation products like wine, vinegar, etc.

### **BIO-VI.E-13: BIOETHICS AND BIOSAFETY**

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

CLO1: Understand importance of general safety measures in laboratories and biosafety guidelines.

CLO2: Justify the design of confinement facilities at different Biosafety levels.

CLO3: Implement good laboratory practices.

CLO4: Discuss the relevance of intellectual property rights to biotechnological innovations.

CLO5: Describe the standard operating procedures for disposal of various types of wastes from the Biotechnology laboratory.

### **BIO-VI.E-14 ADVANCED CELL BIOLOGY**

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

CLO1: Understand the theory behind the working of various techniques in cell biology.

CLO2: Explain the processes of membrane transport and signal transduction.

CLO3: Describe cell cycle events and their regulation.

CLO4: Isolate and visualize the subcellular organelles.

CLO5: Prepare slides and identify various stages of Mitosis and Meiosis.

### **BIO-VI.E-15: FOOD BIOTECHNOLOGY**

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

CLO1: Understand the important spoilage microorganisms in foods and food borne diseases.

CLO2: Explain the principles of various food preservation techniques and the importance of food quality assurance.

CLO3: Debate on the Pros and cons of GM foods.

CLO4: Evaluate MIC of food preservatives.

CLO5: Assess the quality of milk through various tests.

### **BIO-VI.E-16: ANIMAL CELL CULTURE**

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

CLO1: Understand the basic concepts of animal cell culture.

CLO2: Comprehend the various requirements and techniques for animal cell culture and importance of the same.

CLO3: Understand the importance of primary and established cell lines for biotechnological applications.

CLO4: Appreciate the various methods of characterization and growth assessment techniques in culturing animal cells.

CLO5: Understand the applications of animal cells in the development of disease diagnostics and therapeutics.

## **11. Teaching-Learning-Evaluation Pedagogies**

### ***Teaching-Learning pedagogies***

Learners should be encouraged to focus on key areas of the course and spend time on learning the course fundamentals and their application. In teaching and learning pedagogy, there should be a shift from domain-based approach to the experiential-based approach. The teaching of undergraduate Biotechnology for each course, shall include lectures followed by laboratory hours for that particular course. Lectures can have good proportion of visuals learning component and ICT enabled delivery. In order to achieve its objective of focused process based learning and holistic development the department uses various teaching methodologies such as, lecture method, group discussion, problem solving, and other innovative methods such as flipped classrooms, case studies, laboratory work, project work, study/ field visits.

#### **Lectures**

Class room lectures and use of black/white boards are the usual ways of teaching. Also, use of various ICT tools involving power point presentations, videos, animations, models, improve the understanding and make the teaching sessions enjoyable.

#### **Group Discussion, team work and problem solving**

Discussions are critical components of learning, can be used as a platform for students to be creative and critical with old and new ideas, arriving at consensus on various scientific issues and

discussions will lead to development of innovative problem-solving attitude that would contribute to success. In the process of team work, learners will acquire the skills of managing knowledge acquisition and other collaborative learners, thereby understanding how to incorporate and balance personalities.

#### Flipped classrooms

To make teaching-learning interactive and an enjoyable process, various cooperative learning strategies such as, One-stray method, think-pair-share, three step interviews, Padlet, PolleV, ED puzzle, etc are being used.

#### Case Studies

To express acquired knowledge, skills and attitudes, case-based learning can be used where the students are given case specific problems both for theory and practical courses to find creative solutions to complex problems in the concerned areas of life sciences.

#### Laboratory work

As biotechnology graduates in their career opt for research, industrial jobs, hence more emphasis is given in enhancing basic laboratory skills.

#### Project work

The students are encouraged to carry out mini projects of their choice to enable them have first-hand experience toward basic research.

#### Study/ field visits

The visits to research institutes such as, NCPOAR, NIO, ICAR, Goa University, BITS-Pilani campus in Goa and CFTRI, Mysuru. Also visits to various Biopharmaceutical Industries such as MabPharma Pvt. Ltd., Vergo Biotech Pvt. Ltd., Vergo Clinicals Pvt. Ltd., Cipla Pvt. Ltd., in Goa and Monsanto Research Pvt, Ltd., Natural Remedies Pvt. Ltd., etc and visits to anthropological and scientific museums provide opportunities to the students to explore further their theory and practical learning to understand the basic and applied aspects of different sub-areas of Biotechnology.

#### ***Evaluation pedagogies***

The department carries out assessment of the learners of B.Sc. biotechnology students through Formative assessments (Continuous Assessments such as, Objectives, Subjective test, MCQs, Oral presentations, E-assignments writing, Open or Closed book tests)

Summative assessments (Semester End Examination as 2-hour test).

Practical Continuous Assessments (understanding and performing laboratory experiments, case study discussion within a peer group) and any other pedagogic approaches as may be relevant keeping in view the learners' level, credit load and class size.

## **12. Activities of the Department**

The department organizes workshop / seminar/guest lecture in subject specific domains; annual inter-collegiate event 'Synapse' and other fun-learning activities for Biotechnology students and alumni every year under the Biotechnology club – Biochrome to develop critical thinking, leadership qualities, team work, analysis and problem solving towards understanding the need for sustainable solutions and help them develop practical skills for developing an inclination towards research. The final year students are encouraged to present their project finding in State/ National/ International level Seminars/ Conferences which help them develop self-confidence, presentation skills and they also get an opportunity to experience and learn the recent developments in the field of Biotechnology.

## **13. Course Syllabus**

### **First Year B.Sc. Biotechnology course syllabus**

#### **BIO-I.C-1: BIOMOLECULES**

COURSE TITLE: BIOMOLECULES (THEORY)

COURSE CODE: BIO-I.C-1

MARKS: 75

CREDITS: 3

TOTAL HOURS: 45

#### **Course Objective**

This course provides basic foundation on biomolecules of life with reference to their properties, and biological functions. The course also provides detailed knowledge on how cellular structure and function arise as a result of the properties of cellular macromolecules.

#### **Course Outcomes**

On the successful completion of this course the students will be able to:

CO1: Discuss the structure of atoms, biomolecules and chemical bonds.

CO2: Understand concepts of enzyme kinetics, bio-polymers and metabolic reactions in a living system.

CO3: Understand and apply general laboratory safety measures as well as calculate for preparation of various chemicals for experiments.

CO4: Prepare different solutions such as buffers, reagents and stock solutions for experiments independently.

CO5: Operate various lab instruments such as weighing balance, water bath and spectrophotometer.

#### **BIO-I.C-1: BIOMOLECULES (THEORY)**

##### ***Module I (15 hrs)***

##### **The foundations of Biochemistry - 2 hrs**

Landmarks in the history of Biochemistry (contributions particularly by Louis Pasteur, Carl Neuberg, Wilhelm Kuhne, Eduard Buchner); Urey-Millers experiment.



**Carbohydrates 6 hrs**

Monosaccharides: Structure of aldoses and ketoses, ring structure of sugars; Stereochemistry: mutarotation, anomers, epimers and enantiomers; formation of disaccharides, reducing and non-reducing disaccharides; Polysaccharides: homo and hetero-polysaccharides, structural and storage polysaccharides.

**Proteins - 7 hrs**

Amino acids: Structure and nomenclature, General properties, Zwitterions, derivatives of amino acids and their biological role; Proteins: Peptide bond formation, structural Levels of protein; Polypeptides: Structure and function of Collagen, Elastin, Myoglobin and Haemoglobin; binding of oxygen to Myoglobin and Haemoglobin; Protein folding and misfolding; denaturation of Proteins.

**Module II (15 hrs)****Lipids - 7 hrs**

Fatty acids (saturated & unsaturated); Simple Lipids: Fats, oils, waxes; Compound Lipids: Phospholipids & Glycolipids; Derived Lipids: Steroids.

**Nucleic acids - 8 hrs**

DNA structures and their importance, different types of RNA, unusual DNA structures, other functions of nucleotides: a source of energy, component of coenzymes, second messengers.

**Module III (15 hrs)****Water and Molecular interactions - 3 hrs**

Structure and unique properties; Covalent bonds, Hydrogen bonds, Ionic bonds, Hydrophobic bonds and Vander waals interactions.

**Vitamins - 5 hrs**

Structure and active forms of water soluble and fat-soluble vitamins; deficiency diseases and hypervitaminosis

**Hormones - 2 hrs**

Classification and functions

**Enzymology 5 hrs**

Classification of enzymes; Mechanism of enzyme action, Lock & key theory & Induced fit theory; Factors affecting enzymes activity (pH, temperature, enzyme concentration, substrate concentration); MM equation, Lineweaver-Burk plot; Enzyme Inhibition and its types; Ribozymes & Isoenzymes.

**BIO-I.C-1: BIOMOLECULES (PRACTICAL)**

COURSE TITLE: BIOMOLECULES (PRACTICAL)

COURSE CODE: BIO-I.C-1

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

1. Introduction to safety measures in laboratories
2. Preparation of buffers & solutions (normal, molar, ppm, %)
3. Qualitative tests for carbohydrates, lipids, proteins and nucleic acids

4. Principle and working of a colorimeter and spectrophotometer
5. Determination of  $\lambda_{\text{max}}$  and Molar extinction coefficient of a given compound
6. Estimation of reducing sugar - DNSA method
7. Estimation of protein – Folin Lowry's method
8. Titration curve of any one amino acid
9. Determination of peroxide value of oil
10. Effect of pH and temperature on amylase activity

## REFERENCES

1. Nelson, D. L. & Cox, M.M. (2000), Lehninger's Principles of Biochemistry (3rd Edition), Worth Publishers, New York, USA.
2. Stryer, L. (1995). Biochemistry, W.H. Freeman and Co., New York, USA.
3. Jain, J. L (1999), Fundamentals of Biochemistry, S.Chand and Company, New Delhi.
4. Murray, R.K, Granner, D.K, Mayes, P.A. & Rodwell, V.W. (2003), Harper's Illustrated Biochemistry, McGraw-Hill Companies.
5. Sadasivam, S. And Manickam, A. (1996), Biochemical Methods, New Age International (P) Limited
6. Jayaraman, J. (1971), Laboratory Manual in Biochemistry, John Wiley & Sons, Limited.
7. Plummer, D.T. (1993). An Introduction to Practical Biochemistry, Sixth Reprint. Tata McGraw-Hill Publishing Company Limited, New Delhi.
8. Harvey, R.A. & Ferrier, D.R. (2011). Lippincott's Illustrated Reviews, Biochemistry Fifth Edition, Lippincott Williams and Wilkins.

## WEB REFERENCES

1. <https://www.ncbi.nlm.nih.gov/books/NBK21139/> (Carbohydrates)
2. <https://www.ncbi.nlm.nih.gov/books/NBK173989/> (vitamins)
3. [nature.com/scitable/topicpage/protein-structure-14122136/](https://www.nature.com/scitable/topicpage/protein-structure-14122136/) (proteins)
4. <https://www.sciencedirect.com/topics/neuroscience/enzymes> (Enzymes)
5. <https://www.britannica.com/science/hormone> (hormones)

## BIO-I.C-2: CELL BIOLOGY

### COURSE TITLE: CELL BIOLOGY (THEORY)

COURSE CODE: BIO-I.C-2

MARKS: 75

CREDITS: 3

TOTAL HOURS: 45

### Course Objective

The course will give a detailed description of the organization of the cell, the structure and functions of various organelles. The course also focuses on the communication cells and the importance of cell division

### Course Outcomes

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

CO1: Correlate the function of each cell organelle with proper coordination.

CO2: Demonstrate an understanding of cell communication.

CO3: Prepare various plant and animal specimens for observation of cell structures

CO4: Identify and analyze different biological cells using a compound microscope.

## **BIO-I.C-2: CELL BIOLOGY (THEORY)**

### ***Module I (15 hrs)***

#### **Introduction to cell biology - 6 hrs**

Cell theory; ultrastructure of prokaryotic and eukaryotic cell; cell matrix proteins; components of extracellular matrix.

#### **Cell wall & Plasma membrane - 9 hrs**

Chemical composition; structure and functions of the cell wall and plasma membrane; monolayer; planar bilayers and liposomes as model membrane systems; Fluid mosaic model; lipid rafts; membrane fluidity; factors affecting membrane fluidity; techniques used to study membrane dynamics – FRAP.

### ***Module II (15 hrs)***

#### **Ultrastructure and function of organelles - 15 hrs**

Cilia and Flagella; Endoplasmic reticulum; Golgi apparatus; lysosomes; Microbodies; Mitochondria; Ribosomes; Centrioles and basal bodies; Nucleus; Chloroplasts and Peroxisomes.

### ***Module III (15 hrs)***

#### **Cell Cycle - 5 hrs**

Overview of the cell cycle; prokaryotic & eukaryotic cell cycle; events of mitotic & meiotic phases, cytokinesis.

#### **Cell-Cell interaction - 10 hrs**

Interactions of cells with extracellular materials: integrins, focal adhesions and hemidesmosomes; interactions of cells with other cells: selectins, the immunoglobulin superfamily, cadherins, adheren junctions and desmosomes; tight junctions, gap junctions and plasmodesmata.

## **BIO-I.C-2: CELL BIOLOGY (PRACTICAL)**

COURSE TITLE: MOLECULAR MEDICINE (PRACTICAL)

COURSE CODE: BIO-I.C-2

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

1. Examination of prokaryotic cell, eukaryotic cell and cell organelles using Photomicrographs
2. Visualization of animal and plant cell using methylene blue
3. Study of cell viability using phenol red / trypan blue
4. Visualization of Permanent slides of:
  - a. A. Different cell types: Epithelium, Endothelium, Muscle cells, Nerve cell
  - b. B. Different stages of cell division
5. Identification of different stages of mitosis in onion root tip
6. Identification of different stages of meiosis in onion flower buds
7. Isolation of chloroplasts from spinach leaves
8. Prokaryotic cell harvesting & lysis using osmotic (salt) and Chemical (detergent) methods

## REFERENCES

1. Karp, G. & Harris, D. (2008) Cell and Molecular Biology – Concepts and Experiments, John Wiley & Sons Inc, New York.
2. Robertis, E.D.P. & Robertis, E.M.F. (1998). Cell Biology and Molecular Biology, 8th edition, Sauder College.
3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.
4. Verma P.S. and Agarwal V. K. (1998). Cell Biology, Genetics, Molecular Biology, Evolution and ecology.

## WEB REFERENCES

1. <https://www.ncbi.nlm.nih.gov/books/NBK9851/> (Cell - Cell Interaction)
2. <https://www.khanacademy.org/test-prep/mcat/cells/eukaryotic-cells/a/organelles-article> (Cell Organelles and Structures)
3. <https://www.ncbi.nlm.nih.gov/books/NBK9876/> (Phases of the cell cycle)
4. <https://www.ncbi.nlm.nih.gov/books/NBK10019/> (Meiosis)
5. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC158550/> (Effect of temperature on Membrane Fluidity)

## BIO-II.C-3: FUNDAMENTAL GENETICS

COURSE TITLE: BIOMOLECULES (THEORY)

COURSE CODE: BIO-II.C-3

MARKS: 75

CREDITS: 3

TOTAL HOURS: 45

### Course Objective

Genetics allows for the understanding of the structure and function of genes and chromosomes as well as the harmful effects of mutations which can cause various genetic disorders.

### Course Outcomes

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

CO1: Outline the basic principles of Mendelian genetics and compare and analyse different inheritance patterns as well as solve problems based on genetic principles.

CO2: Compare and contrast different mutations, their effects on cells and the application of the same to research.

CO3: Differentiate between the structure and working of a compound and dissection microscope.

CO4: Construct and interpret a karyotype prepared from a spread of metaphase chromosomes

## BIO-II.C-3: FUNDAMENTAL GENETICS (THEORY)

### Module I (15 hrs)

#### Introduction to Genetics - 2 hrs

Scope and importance of Genetics; terminology.

#### Mendelian Genetics - 9 hrs

Mendel's experiments; principle of segregation; monohybrid crosses (dominance, recessive, co-dominance, incomplete dominance); principle of independent assortment; multiple alleles ABO

blood type, Rh factor alleles in humans; genotypic interaction, epistasis, pleiotropy, extra-nuclear inheritance.

#### **Chromosomes - 4 hrs**

Chromosome number; morphology; chromosome material and chemical composition; giant chromosomes.

#### **Module II (15 hrs)**

##### **Introduction to the concepts - 2 hrs**

Inbreeding, heterosis, hybrid vigour.

##### **Cell Cycle and cell division - 4 hrs**

Cell cycle - G1, S and G2 phase; Mitosis and Meiosis, Cell cycle checkpoints.

##### **Linkage and Crossing Over - 4 hrs**

Concept of linkage and crossing over, Sutton-Boveri Chromosome theory of inheritance; coupling and repulsion hypothesis; types of linkage (complete and incomplete); types of crossing over; mechanism of meiotic crossing over & significance.

##### **Population Genetics - 5 hrs**

Gene pool; theory of allele frequencies (gene and genotypic frequencies); the Hardy-Weinberg principle and its application; exceptions to the Hardy-Weinberg principle -natural selection; random genetic drift; problems on Hardy-Weinberg principle; speciation-definition of species and mode of speciation (allopatric, sympatric).

#### **Module III (15 hrs)**

##### **Sex Determination, Sex Linkage and Pedigree Analysis - 8 hrs**

Sex determination (pattern and sex chromosomes); sex determination in human beings and flowering plants; dosage compensation; sex-linked inheritance – Haemophilia, Duchenne Muscular Dystrophy, Fragile X Syndrome, Colour blindness; pedigree Analysis – penetrance and expressivity; family tree; dominant inheritance; recessive inheritance.

##### **Structural and Numerical Chromosomal Mutations - 4 hrs**

Types of structural changes (deletion, duplication, inversion, translocation, variation in chromosome morphology); types of numerical changes (euploidy and aneuploidy).

##### **Human Genetics - 3 hrs**

Gene action and related diseases (Alkaptonuria, Phenylketonuria, Sickle Cell Anaemia); autosomal and sex chromosomal anomalies involving numerical and structural aberrations. (Down's, Cri-du-chat, Klinefelter's and Turner's syndromes).

#### **BIO-II.C-3: FUNDAMENTAL GENETICS (PRACTICAL)**

COURSE TITLE: FUNDAMENTAL GENETICS (PRACTICAL)

COURSE CODE: BIO-II.C-3

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

1. Study of a dissection microscope.
2. Study of Barr bodies in sex determination.
3. Study of Polytene chromosomes.
4. Study of Mendelian traits in human population

5. Problem solving on Mendel's Laws & Hardy-Weinberg's Law
6. Karyotype analysis of chromosomal abnormalities
7. Pedigree analysis and problem solving.

## REFERENCES

1. Gardner, E. J., Simmons, M. J. & Snustad, D. P. (2013). Principles of Genetics, 8<sup>th</sup> Edition, John Wiley and Sons.
2. Hotter, P. (2007). Dictionary of Genetics, IVY Publishing House, Delhi
3. Jayaraman, K. & Jayaraman, R. (1979). Laboratory manual in Molecular Genetics, John Wiley and Sons.
4. Tamarin, R.H. (2002). Principles of Genetics, 7<sup>th</sup> Edition, Tata McGraw-Hill Publishing Company Ltd.
5. Verma, P.S. & Agarwal, V.K. (2013). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, S. Chand & Company Pvt. Ltd.

## WEB REFERENCES

1. <https://journals.sagepub.com/doi/full/10.1177/0962280215597579> (mendelian genetics)
2. <https://link.springer.com/article/10.1007/s10577-017-9562-z> (Giant chromosomes)
3. <https://www.sciencedirect.com/science/article/abs/pii/S0962892416301271> (cell cycle, division)
4. <https://onlinelibrary.wiley.com/doi/abs/10.1111/mec.13736> (linkage and crossing over)
5. <https://onlinelibrary.wiley.com/doi/abs/10.1002/em.21945> (Structural, numerical chromosomal mutations)
6. <https://www.genetics.org/content/203/2/699.short> (pedigree analysis)

## BIO-II.C-4: BASIC MICROBIOLOGY

COURSE TITLE: BASIC MICROBIOLOGY (THEORY)

COURSE CODE: BIO-II.C-4

MARKS: 75

CREDITS: 3

TOTAL HOURS: 45

### Course Objective

The main aim of this course is to introduce the students to the vast world of Microbiology. This course covers a range of topics in Basic Microbiology from the historical perspective to the structure and composition of microorganisms, their interactions with the environment and their impact on humans.

### Course Outcomes

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

- CO1: Understand the scope and importance of Microbiology, classification schemes, cultivation, preservation and maintenance of microbial cultures.
- CO2: Discriminate between various groups of microorganisms and also comprehend the beneficial and harmful effects of each group of microorganisms.
- CO3: Compare, analyse, apply the concepts of principle, working of microscopes types.
- CO4: Adhere to strict laboratory safety measures to be followed in a microbiology laboratory.
- CO5: Master skills in aseptic techniques as well comprehend the importance of cleaning and decontamination.

## **BIO-II.C-4: BASIC MICROBIOLOGY (THEORY)**

### ***Module I (15 hrs)***

#### **History and Scope of Microbiology - 2 hrs**

Historical account from 16th – 19th century

#### **Basics of Microscopy - 3 hrs**

Principle of working of light microscope (Bright-field, Dark-field, Phase-contrast, Fluorescence).

#### **Bacterial Taxonomy - 8 hrs**

Introduction to Archaea; taxonomic ranks; classification systems (Phenetic, Numerical, Phylogenetic); Bergey's Manual of Systematic/ Determinative Bacteriology and rDNA sequencing.

#### **Reproduction in bacteria - 1 2 hrs**

Binary fission; definitions: cell growth, growth rate, generation time

### ***Module II (15 hrs)***

#### **Cultivation of microorganisms - 8 hrs**

Sterilisation; disinfection; decontamination: principle and methods; types of culture media: synthetic/defined, complex solid, liquid, enrichment, selective, differential; cultivation of microorganisms: broth culture, agar plate, pour plate; determination of viable count: serial dilution; spread plating; determination of colony forming units (CFU) and calculation of viable count; isolation of pure cultures: streak plate; colony morphology.

#### **Maintenance and preservation of microbial cultures - 4 hrs**

Slant and stab cultures; periodic transfer; storage in sterile soil; overlaying with mineral oil; glycerol stocks; preservation in liquid nitrogen; lyophilisation.

#### **Bacteria in Extreme Environments - 3 hrs**

Thermophiles, barophiles, halophiles, acidophiles and alkaliphiles.

### ***Module III (15 hrs)***

#### **Organization and Ultrastructure of a Bacterial cell 8 hrs**

Cell wall: structure and chemical composition in Gram positive and Gram-negative bacteria; introduction to cell membrane, pili, fimbriae and capsule; flagella structure and function; nucleoid and plasmids: nature and function; endospore: structure, sporulation and germination; reserve materials.

#### **Reproduction in bacteria - 2 hrs**

Bacterial growth curve; characteristics of growth phases; diauxic growth curve, continuous and synchronous growth

#### **Viruses - 5 hrs**

Basic classification and structure of viruses (prokaryotic and eukaryotic); characteristic features of phage; viral replication (lytic and lysogenic).

## **BIO-II.C-4: BASIC MICROBIOLOGY (PRACTICAL)**

COURSE TITLE: BASIC MICROBIOLOGY (PRACTICAL)

COURSE CODE: BIO-II.C-4

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

1. Introduction to laminar air flow unit, autoclave, pH meter, incubator, microwave & microscope

2. Preparation and sterilization of glassware
3. Preparation of media and autoclaving
4. Preparation of agar plates and open-air cultures
5. Serial dilution technique and spread plating
6. Bacterial isolation techniques: streaking methods such as, simple continuous, T-streak, quadrant, radiant.
7. Preparation and staining of specimen- simple staining, Gram staining, endospore staining
8. Biochemical tests for bacterial identification: sugar fermentation and IMViC tests
9. Isolation and staining of Fungi by lactophenol cotton blue
10. Cleaning and decontamination.

## REFERENCES

1. Anantnaryan, Paniker, C.K.J. (2005). Textbook of Microbiology, 7th edition, Orient Blackswan.
2. Aneja, K. R. (2007). Experiments in Microbiology, Plant Pathology and Plant Tissue Culture, New Age International.
3. Gunasekaran, P. (1995). Laboratory Manual in Microbiology, New Age International.
4. Madigan, M. T., Martinko. J. M. & Parker J. (2007). Brock's Biology of Microorganisms, Pearson Prentice Hall.
5. Pelczar, M.J., Chan E, C.S. & Krieg, N.R. (1993). Microbiology, Fong & Sons Printers Pvt. Ltd.
6. Stanier, R.Y. (1993) General Microbiology, Cambridge University.
7. Willey, J. M., Sherwood, L., Woolverton, C. J. & Prescott, L. M. (2008). Prescott, Harley, and Klein's Microbiology, New York, McGraw-Hill Higher Education.

## WEB REFERENCES

1. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5524440/> (History of Microbiology)
2. <https://microbeonline.com/streak-plate-method-principle-purpose-procedure-results/> (Streaking)
3. <https://www.khanacademy.org/science/biology/bacteria-archaea> (Bacteria and Archaea)
4. <https://www.khanacademy.org/science/biology/bacteria-archaea/prokaryotemetabolismecology/a/prokaryote-classification-and-diversity> (Prokaryotic Taxonomy)

## Second Year B.Sc. Biotechnology course syllabus

### BIO-III.C-5: MOLECULAR BIOLOGY

COURSE TITLE: MOLECULAR BIOLOGY (THEORY)

COURSE CODE: BIO-III.C-5

MARKS: 75

CREDITS: 3

TOTAL HOURS: 45

#### Course objective

This paper provides insight on replication, transcription and translation process in prokaryotes and eukaryotes, various mutations and their repair mechanisms, regulation of gene expression and mechanism of gene transfer.

#### Course Outcomes

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

CO1: Explain the structure of DNA and its properties

CO2: Distinguish between DNA, RNA and Proteins



CO3: Understand basic concepts in molecular biology

CO4: Compare differences between replication, transcription and translation processes in prokaryotes and eukaryotes.

CO5: Describe the mechanism of gene transfer and regulation

### **BIO-III.C-5: MOLECULAR BIOLOGY (THEORY)**

#### ***Module I (15 hrs)***

##### **Basic Concepts in Molecular Biology 7 hrs**

Experiments proving DNA as genetic material: S. F. Griffith's transforming principle; Avery and Hershey and Chase Experiment; evidence for RNA as the genetic material of some viruses; Chargaff's experiments and law; Watson – Crick Model.

##### **DNA Replication - 8 hrs**

Experimental evidence for semi-conservative DNA replication in *E. coli* - Meselson and Stahl's experiment; the basic requirements of DNA replication: template, DNA polymerases: structure and function, ancillary proteins associated with replication; mechanism of replication in prokaryotes: initiation, elongation and termination; mechanism of DNA replication in eukaryotes; replication of circular DNA (rolling circle model).

#### ***Module II (15 hrs)***

##### **DNA Damage and its Repair - 6 hrs**

Mutations and types of mutations: spontaneous and induced mutation, missense, silent, frameshift, reversion; physical and chemical mutagens (ethidium bromide, alkylating agents, base analog); DNA Repair Mechanisms: Mismatch, photo-reactivation repair, Excision repair.

##### **Transcription - 9 hrs**

Mechanism of prokaryotic transcription - transcription factors and machinery; formation of initiation complex; RNA polymerase enzyme; initiation, elongation and termination; transcription in eukaryotes- eukaryotic RNA polymerases, transcription factors, promoters, enhancers, mechanism of transcription; RNA processing: capping, splicing, polyadenylation.

#### ***Module III (15 hrs)***

##### **Protein Synthesis - 9 hrs**

Central dogma and genetic code; mechanism of protein synthesis in prokaryotes - initiation, elongation and termination; mechanism of protein synthesis in eukaryotes- activation of amino acids, initiation, elongation and termination; post-translational modifications- phosphorylation, acylation, glycosylation & disulphide linkage.

##### **Regulation of Gene Expression - 3 hrs**

Lactose operon; Tryptophan operon

##### **Mechanism of Gene transfer - 3 hrs**

Conjugation; transformation; transduction

### **BIO-III.C-5: MOLECULAR BIOLOGY (PRACTICAL)**

COURSE TITLE: MOLECULAR BIOLOGY (PRACTICAL)

COURSE CODE: BIO-III.C-5

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

1. Isolation of genomic DNA from prokaryotes
2. Isolation of genomic DNA from eukaryotes
3. Isolation of genomic RNA
4. Agarose gel electrophoresis
5. Determination of molecular size of DNA by agarose gel electrophoresis
6. Mutagenesis in *E. coli* cells – UV survival or chemical mutagens
7. Purity of DNA by spectrophotometric method

## REFERENCES

1. Krebs, J.E., Goldstein, E.S. & Kilpatrick, S.T. (2014). *Lewin's Genes XI*, Jones and Bartlett India Pvt. Ltd.
2. Nelson, D. L. & Cox, M.M. (2000). *Lehninger's Principles of Biochemistry* (3rd Edition), Worth Publishers, New York, USA.
3. Karp, G. & Harris, D. (2008) *Cell and Molecular Biology – Concepts and Experiments*, John Wiley & Sons Inc, New York.
4. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). *Cell and Molecular Biology*. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
5. Watson, J.D., Hopkins, N.H. et al. (2008). *Molecular Biology of the Gene*, Garland Publishing (Taylor & Francis Group), New York & London.
6. Verma, P.S. & Agarwal, V.K. (2013). *Cell Biology, Genetics, Molecular Biology, Evolution and Ecology*, S. Chand & Company Pvt. Ltd.

## WEB REFERENCES

1. <https://www.elsevier.com> > ... > Molecular Biology
2. <https://open.umn.edu> > opentextbooks > textbooks > cell-and-molecular-bi...
3. <https://molbiomadeeasy.files.wordpress.com> > 2013/09 > fundamental\_mol...
4. <https://www.academia.edu> > Cell\_and\_Molecular\_Biology\_Concepts\_and\_...
5. <https://en.wikipedia.org> > wiki > Edward\_M.\_De\_Robertis

## BIO-III.E-1: BASICS OF PLANT AND ANIMAL SCIENCES

COURSE TITLE: BASICS OF PLANT AND ANIMAL SCIENCES (THEORY)

COURSE CODE: BIO-III.E-1

MARKS: 75

CREDITS: 3

TOTAL HOURS: 45

### Course Objective

This paper will provide students with an insight into the Plant and Animal Kingdoms and classification into different phyla. They will understand the variety of habitats that support the growth and reproduction of different plants and animals and will also look into the general characteristics and adaptations exhibited by these organisms.

### Course Outcome

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

CO1: Explain classification of plant and animal kingdom

CO2: Distinguish between various phyla of the plant and animal kingdoms based on characteristics

CO3: Compare and contrast the differences in morphology and anatomy in Angiosperms

CO4: Explain features of the non-chordates and chordates

CO5: Sketch the morphology and anatomy of selected plant and animal specimens.

### **BIO-III.E-1: BASICS OF PLANT AND ANIMAL SCIENCES (THEORY)**

#### ***Module I (15 hrs)***

##### **Introduction - 1 hr**

Introduction to the plant and animal kingdom; introduction to classification systems

##### **Plant Kingdom - 7 hrs**

Study of the general characteristics of Algae, Fungi, Lichens, Bryophytes, Pteridophytes, Gymnosperms

##### **Morphology and Anatomy in Angiosperms - 7 hrs**

Vegetative morphology of roots; stem and leaf reproductive morphology of flower; inflorescence, fruits; comparative anatomy of roots, stem and leaves in monocots and dicots; secondary growth in angiosperms

#### ***Module II (15 hrs)***

##### **Animal Kingdom - Non chordates - 10 hrs**

Study of habitat and general characteristics of Protozoa, Porifera, Cnidaria, Platyhelminthes, Aschelminthes, Annelida, Arthropoda, Mollusca, Echinodermata

##### **Animal Kingdom–Chordates - 5 hrs**

Study of habitat and general characteristics of: superclass Pisces; class Amphibia; class Reptilia; class Aves; class Mammalia

#### ***Module III (15 hrs)***

##### **Salient features of non-chordates - 8 hrs**

Study of salient features of non-chordates: disease-causing Protozoa, Platyhelminthes and nematodes (Aschelminthes); circulation in Porifera -water vascular system in Echinoderms; Excretion in Aschelminthes and Annelida; torsion in Gastropods (Mollusca); metamorphosis in insects and economic importance (Arthropoda); corals and coral reefs (Cnidaria)

##### **Salient features of Chordates - 7 hrs**

Study of salient features of chordates: economic importance of fishes; parental care in amphibians; venomous and non-venomous reptiles; migration in birds; dentition in mammals

### **BIO-III.E-1: BASICS OF PLANT AND ANIMAL SCIENCES (PRACTICAL)**

COURSE TITLE: BASICS OF PLANT AND ANIMAL SCIENCES (PRACTICAL)

COURSE CODE: BIO-III.E-1

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

1. Study of algal types through temporary mounting: (*Chlorella* and *Anabaena*)
2. Microscopy study of thallus structures in *Riccia* and *Cycas*
3. Preparation of mycorrhizal slides by trypan blue method
4. T.S of monocot and dicot root
5. T.S of monocot and dicot stem
6. T.S of monocot and dicot leaf

7. Observation of permanent slides: Anther, ovules, embryo sac, embryo
8. Study of specimens with reference to habit, habitat, characteristic features: two examples from each Invertebrate major phylum.

## **REFERENCES**

1. Barnes, R.D. (2000). Invertebrate Zoology, Hall Saunders International Editions.
2. Jordan, E.L. & Verma, P.S. (2000). Invertebrate Zoology, S. Chand & Co. Pvt. Ltd. New Delhi.
3. Jordan, E.L. & Verma, P.S. (2006). Chordate Zoology, New Edition, S. Chand & Co. Pvt. Ltd. New Delhi.
4. Pandey, S.N., Misra, S.P. & P S Trivedi. (2015). A Textbook of Botany, Volume I, Vikas Publishing House Pvt. Ltd.
5. Pandey, S.N., Misra, S.P. & P S Trivedi. (2016). A Textbook of Botany, Volume II, Vikas Publishing House Pvt. Ltd.
6. Verma, V. (2010). Botany, Ane Books, Pvt. Ltd.

## **WEB REFERENCES**

1. [https://www.researchgate.net/publication/228542744\\_Paleobotany\\_Some\\_Aspects\\_of\\_Non-Flowering\\_and\\_Flowering\\_Plant\\_Evolution](https://www.researchgate.net/publication/228542744_Paleobotany_Some_Aspects_of_Non-Flowering_and_Flowering_Plant_Evolution) (Angiosperms and Gymnosperms)
2. <https://www.journals.elsevier.com/algal-research> (Algae)
3. <https://academic.oup.com/mbe/article/23/3/541/1110188> (Chordates)
4. <https://www.sciencedirect.com/science/article/pii/S0960982211008311> (Metamorphosis)
5. <https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/echinodermata> (Echinodermata)

## **BIO-III.E-2: METABOLISM OF BIOMOLECULES**

COURSE TITLE: METABOLISM OF BIOMOLECULES (THEORY)

COURSE CODE: BIO-III.E-2

MARKS: 75

CREDITS: 3

TOTAL HOURS: 45

PRE-REQUISITES: Completion of BIO-I.C-1- Biomolecules

### **Course objectives**

While the core course in Biomolecules explored the different biomolecules, their structure and function, this elective aim to provide clarity to those basics by integrating the processes of metabolism and observing their function under different conditions.

### **Course Outcomes**

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

CO1: Understand and explain the metabolic processes of the human body

CO2: Explain the interconnections of metabolic pathway.

CO3: Explain the effect of diet on metabolism and defects caused due to improper metabolism.

CO4: Estimate and isolate various biomolecules using spectrophotometry, Thin layer chromatography & centrifugation techniques.

CO5: Understand and describe the causes and treatment of various metabolic disorders through case studies.

## **BIO-III.E-2: METABOLISM OF BIOMOLECULES (THEORY)**

### ***Module I (15 hrs)***

#### **Basic concepts and design of metabolism - 2 hrs**

Definition of metabolism; catabolism; anabolism; ATP as energy currency; energy relationship between catabolic and anabolic pathways

#### **Carbohydrate metabolism - 9 hrs**

Glycolysis; gluconeogenesis; pentose-phosphate pathway; glycogen synthesis and breakdown and its regulation; tricarboxylic acid cycle; glyoxylate pathway

#### **Amino acid catabolism and anabolism - 4 hrs**

Overview of biosynthesis and catabolism of amino acids; Urea cycle

### ***Module II (15 hrs)***

#### **Fatty acid synthesis and degradation - 7 hrs**

Digestion; mobilization and transport of cholesterol and triacylglycerols; oxidation of fatty acids; ketone bodies; biosynthesis of fatty acids - elongation and unsaturation of fatty acids.

#### **Oxidative phosphorylation - 4 hrs**

The respiratory chain in mitochondria; proton gradient powering ATP synthesis; Transfer of cytosolic reducing equivalents to mitochondria: glycerol-3- phosphate and malate-aspartate shuttle

#### **Nucleotide metabolism - 4 hrs**

Biosynthesis - *de novo* and salvage pathways; degradation.

### ***Module III (15 hrs)***

#### **Integration of Metabolism - 8 hrs**

The Feed-Fast Cycle: overview; enzymatic changes; activity in the liver; adipose tissue; resting skeletal muscle and brain during absorptive state; overview; activity in liver, adipose tissue, resting skeletal muscle, brain and kidney during fasting.

#### **Metabolic Disorders - 7 hrs**

Clinical characteristics; diagnosis and management of: Ehlers Danlos syndrome (Classic type), Lesch-Nyhan syndrome, Alzheimer's disease; Xeroderma pigmentosum; Crutzfeldt-Jakob disease; Gout

## **BIO-III.E-2: METABOLISM OF BIOMOLECULES (PRACTICAL)**

COURSE TITLE: METABOLISM OF BIOMOLECULES (PRACTICAL)

COURSE CODE: BIO-III.E-2

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

1. Estimation of protein – Biuret method
2. Estimation of DNA by Diphenylamine method
3. Estimation of Urea (serum/urine)
4. Estimation of Uric acid (serum/urine)
5. Estimation of blood glucose
6. Isolation of lecithin from egg yolk

7. Isolation of cholesterol from egg yolk
8. Separation of fatty acids by TLC
9. Estimation of blood cholesterol
10. Case studies: Clinical Characteristics, Diagnosis and Management of:
11. Alzheimer's Disease and Xeroderma pigmentosum, Ehlers Danlos syndrome, Crutzfeldt-Jakob disease.

## REFERENCES

1. Jain, J.L (1999). Fundamentals of Biochemistry, S.Chand and Company, Ltd., New Delhi.
2. Nelson, D. L. & Cox, M.M. (2000). Lehninger's Principles of Biochemistry (3rd Edition), Worth Publishers, New York, USA.
3. Stryer, L. (1995). Biochemistry, W.H. Freeman and Co., New York, USA.
4. Harvey, R.A. & Ferrier, D.R. (2011). Lippincott's Illustrated Reviews, Biochemistry Fifth Edition, Lippincott Williams and Wilkins
5. Plummer, D.T. (2008). An Introduction to Practical Biochemistry, Third Edition, Tata McGraw-Hill.

## WEB REFERENCES

1. <https://www.ncbi.nlm.nih.gov/books/NBK22593/> (Glycolysis)
2. <https://www.ncbi.nlm.nih.gov/books/NBK21528/> (Oxidative Phosphorylation)
3. <https://www.youtube.com/watch?v=J30zpvbmw7s> (Oxidative Phosphorylation)
4. <https://www.ncbi.nlm.nih.gov/books/NBK513323/> (Urea Cycle)
5. <https://www.khanacademy.org/science/biology/cellular-respiration-and-fermentation/pyruvate-oxidation-and-the-citric-acid-cycle/a/the-citric-acid-cycle> (TCA Cycle)
6. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3243375/> (Nucleotide Metabolism)
7. <https://www.ncbi.nlm.nih.gov/books/NBK22459/> (Amino Acid Metabolism)

## BIO-III.E-3: BIOSTATISTICS

COURSE TITLE: BIOSTATISTICS (THEORY)

COURSE CODE: BIO-III.E-3

MARKS: 75

CREDITS: 3

TOTAL HOURS: 45

### Course Objective

The objective of this course is to introduce students to statistical methods and to understand the underlying principles (summarizing data and drawing valid inferences based on limited information). The purpose of the course is to give students an introduction to the discipline, an appreciation of a statistical perspective on information from biology and basic critical skills to assess the quality of research evidence.

### Course Outcomes

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

CO1: Explain the importance of Biostatistics in biology.

CO2: Understand the concepts of Sampling.

CO3: Represent and interpret the data using graphical method and MS Excel

CO4: Solve problems on measures of central tendency, dispersion and hypothesis testing.

CO5: Apply appropriate statistical tools in their project work.

### **BIO-III.E-3: BIOSTATISTICS (THEORY)**

#### ***Module I (15 hrs)***

##### **Scope & importance of Biostatistics - 2hrs**

Definition; importance and applications of Biostatistics

##### **Introduction to Sampling - 3 hrs**

Concepts of: statistical population, sample; advantages and disadvantages of sampling; types of data; collection of data: primary & secondary data; types of sampling – simple; random sampling; stratified random sampling; systematic sampling; cluster sampling.

##### **Graphical & Diagrammatic representation of data - 3 hrs**

Tabulation of data; graphical and diagrammatic representation of data; construction of graphs using MS Excel

##### **Measures of central tendency - 7 hrs**

Characteristics of ideal measure; arithmetic mean – simple, weighted, combined, and corrected mean; limitations of arithmetic mean; median – calculation for raw data, for grouped data, for continuous series, limitations of median; mode – computation of mode for individual series, by grouping method in a continuous frequency distribution, limitations of modes; relationship between mean, median and mode; geometric mean; harmonic mean

#### ***Module II (15 hrs)***

##### **Measures of dispersion -8 hrs**

Quartiles; deciles; percentiles Range, mean deviation, coefficient of mean deviation, standard deviation (individual observations, grouped data, continuous series), variance, coefficient of variance, limitation; Skewness – definition; positive; negative; Karl Pearson's coefficient, Bowley's Coefficient

##### **Correlation analysis - 7 hrs**

Correlation; covariance; correlation coefficient for ungrouped data; Shearson's rank correlation coefficient; scatter and dot diagram (graphical method)

#### ***Module III (15 hrs)***

##### **Regression analysis - 5 hrs**

Regression equation, regression coefficient, examples from biological sciences

##### **Hypothesis testing -10 hrs**

Parameter and statistics; sampling theory; sampling and non-sampling error; confidence limit; testing of hypothesis; test of significance; students' t-test: unpaired & paired; F test; Chi-square test and ANOVA

### **BIO-III.E-3: BIOSTATISTICS (PRACTICAL)**

COURSE TITLE: BIOSTATISTICS (PRACTICAL)

COURSE CODE: BIO-III.E-3

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

1. Problem solving on arithmetic mean, median, mode (measures of central tendency) with reference to biological data.

2. Problem solving on measures of central tendency with reference to biological data using MS Excel.
3. Problem solving on measures of dispersion with reference to biological data.
4. Graphical presentation of data – Construction of various types of graphs and charts based on the given data (Manually and using MS Excel)
5. Problem solving on hypothesis testing

## REFERENCES

1. Banerjee, P.K. (2011). Introduction to Biostatistics, A textbook of biometry, New Delhi, India: S. Chand & Company Ltd.
2. Khan IA & Khanum A. (2009). Fundamentals of Biostatistics, Delhi: Ukaaz publications Hyderabad
3. Rajan, K. (2007). Biostatistics Theory and Problems, New Delhi: India, Himalaya Publishing House.
4. Rastogi, V.B. (2009). Fundamentals of Biostatistics, Ane Books Pvt. Ltd, New Delhi.
5. Ross, S. M. (2010). Introductory Statistics. Third edition, Academic press.
6. Arora P.N. and Malhan P.K., (2006), Biostatistics, 2nd Edition, Himalaya Publishing House

## WEB REFERENCES

1. <http://www.economicsdiscussion.net/statistics/8-functions-of-statistics-scope-and-importance/2325> (Scope & importance of Biostatistics)
2. <https://www.toppr.com/guides/business-economics-cs/descriptive-statistics/diagrammatic-representation-of-data/> (Graphical & Diagrammatic representation of data)
3. <http://www.economicsdiscussion.net/statistics/data/graphical-representation-of-statistical-data/12010> (Measures of central tendency)
4. <https://statisticsbyjim.com/basics/measures-central-tendency-mean-median-mode/> (Measures of central tendency)
5. [http://onlinestatbook.com/2/summarizing\\_distributions/measures.html](http://onlinestatbook.com/2/summarizing_distributions/measures.html) (Measures of central tendency)
6. <https://www.toppr.com/guides/business-mathematics-and-statistics/measures-of-central-tendency-and-dispersion/measure-of-dispersion/> (Measures of dispersion)
7. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3198538/> (Measures of dispersion)
8. [http://sphweb.bumc.bu.edu/otlt/MPHModules/BS/BS704\\_Multivariable/BS704\\_Multivariable5.html](http://sphweb.bumc.bu.edu/otlt/MPHModules/BS/BS704_Multivariable/BS704_Multivariable5.html) (Correlation & regression analysis)

## BIO-III.E-4: ENZYMOLOGY

COURSE TITLE: ENZYMOLOGY (THEORY)

COURSE CODE: BIO-III.E-4

MARKS: 75

CREDITS: 3

TOTAL HOURS: 45

### Course Objective

This course will provide a comprehensive view of enzyme chemistry and kinetics, methods and strategies for enzyme purification and characterization. One section also deals with the applications of enzymes in diagnostics.



## **Course Outcomes**

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

CO1: Explain the structure of an enzyme and kinetics of enzyme catalysed reactions

CO2: Understand different types of enzyme inhibitions

CO3: Understand the wide applications of enzymes and future potential

CO4: Isolate and purify crude forms of enzyme extract and apply appropriate method for determination of activity of enzyme

CO5: Discuss factors that affect enzymatic activity

## **BIO-III.E-4: ENZYMOLOGY (THEORY)**

### ***Module I (15 hrs)***

#### **Introduction to enzymes - 8 hrs**

Nature of enzymes - protein and non-protein (ribozyme); coenzymes, cofactors & prosthetic group; apoenzyme; holoenzyme; ribozymes & isoenzymes; specificity of enzymes; classification of enzymes

#### **Features of enzyme catalysis - 7 hrs**

Fischer's lock and key hypothesis; Koshland's induced fit hypothesis; factors affecting the rate of reactions (time, enzyme concentration, substrate concentration, pH and temperature)

### ***Module II (15 hrs)***

#### **Enzyme kinetics - 8 hrs**

Principles of reaction rates; order of reactions and equilibrium constants; derivation of Michaelis-Menten equation and Lineweaver-Burk plot; significance of  $K_m$  and  $V_{max}$ ,  $K_{cat}$  and turnover number

#### **Enzyme inhibition - 7 hrs**

Reversible inhibition (competitive, uncompetitive, non-competitive, mixed and suicide, end product); mechanism-based inhibitors - antibiotics as inhibitors; types of irreversible inhibition; allosteric inhibition

### ***Module III (15 hrs)***

#### **Mechanisms of enzyme action and regulation - 4 hrs**

Mechanism of action of chymotrypsin; regulation of enzyme activity and its importance – aspartate transcarboxylase

#### **Enzyme purification - 6 hrs**

Purification of enzymes: salt precipitation; dialysis; molecular exclusion chromatography; PAGE; Molecular weight determination by SDS-PAGE

#### **Applications of enzymes - 5 hrs**

Application of enzymes in diagnostics (SGPT, SGOT, creatine kinase, alkaline and acid phosphatases); enzyme immunoassay (HRPO); applications of enzymes in industry – detergents, leather, food

## **BIO-III.E-4: ENZYMOLOGY (PRACTICAL)**

COURSE TITLE: ENZYMOLOGY (PRACTICAL)

COURSE CODE: BIO-III.E-4

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

1. Effect of pH on enzyme activity
2. Effect of temperature on enzyme activity
3. Effect of substrate concentration and determination of  $K_m$  and  $V_{max}$
4. Partial purification of any one enzyme from suitable source- ammonium sulphate precipitation, dialysis
5. Assay of enzyme activity and specific activity
6. SDS-PAGE

## REFERENCES

1. Nelson, D. L. & Cox, M.M. (2000), Leininger's Principles of Biochemistry (3rd Edition), Worth Publishers, New York, USA.
2. Jain, J. L (2005), Fundamentals of Biochemistry, S. Chand and Company Ltd., New Delhi.
3. Murray, R.K, Garner, D.K, Mayes, P.A. & Rodwell, V.W. (2003), Harper's Illustrated Biochemistry, McGraw-Hill Companies.
4. Plummer, D.T. (2006). An Introduction to Practical Biochemistry, Sixth Reprint. Tata McGraw-Hill Publishing Company Limited, New Delhi.
5. Harvey, R.A. & Ferrier, D.R. (2011). Lippincott's Illustrated Reviews, Biochemistry Fifth Edition, Lippincott Williams and Wilkins.

## WEB REFERENCES

1. [https://link.springer.com/chapter/10.1007/978-0-387-72891-9\\_1](https://link.springer.com/chapter/10.1007/978-0-387-72891-9_1) (Introduction to enzymes)
2. <https://teachmephysiology.com/basics/enzyme-activity/enzyme-kinetics/> (Enzyme Kinetics)
3. [https://chem.libretexts.org/Courses/University\\_of\\_California\\_Davis/UCD\\_Chem\\_107B%3A\\_A\\_Physical\\_Chemistry\\_for\\_Life\\_Scientists/Chapters/3%3A\\_Enzyme\\_Kinetics/3.2%3A\\_The\\_Equations\\_of\\_Enzyme\\_Kinetics](https://chem.libretexts.org/Courses/University_of_California_Davis/UCD_Chem_107B%3A_A_Physical_Chemistry_for_Life_Scientists/Chapters/3%3A_Enzyme_Kinetics/3.2%3A_The_Equations_of_Enzyme_Kinetics) (Enzyme Kinetics)
4. [https://en.wikibooks.org/wiki/Structural\\_Biochemistry/Enzyme/Reversible\\_Inhibitors](https://en.wikibooks.org/wiki/Structural_Biochemistry/Enzyme/Reversible_Inhibitors) (Enzyme inhibition)
5. [https://biocyclopedia.com/index/biotechnology/microbial\\_biotechnology/enzyme\\_technology\\_biotech\\_enzyme\\_application.php](https://biocyclopedia.com/index/biotechnology/microbial_biotechnology/enzyme_technology_biotech_enzyme_application.php) (Applications of enzymes)
6. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5956270/> (Applications of enzymes)

## BIO-IV.C-6: IMMUNOLOGY

COURSE TITLE: IMMUNOLOGY (THEORY)

COURSE CODE: BIO-IV.C-6

MARKS: 75

CREDITS: 3

TOTAL HOURS: 45

### Course Objectives

This paper aims at introducing the basic concepts of the immune system and its defense mechanisms. This will help them understand and reason out concepts related to diseases. A section on vaccination, monoclonal and polyclonal antibodies stresses on the importance of these for treatment of lethal diseases.

## **Course Outcomes**

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

CO1: Trace the history of immunology and compare and contrast primary and secondary immune response.

CO2: Gain knowledge of the structure and function of the cells and organs of immune systems

CO3: Describe the mechanisms of Ag-Ab reaction, hypersensitivity reactions and importance of Complement system

CO4: Understand the importance of Monoclonal Ab and various immunodeficiency diseases

CO5: Familiarize various techniques involved in Immunology

## **BIO-IV.C-6: IMMUNOLOGY (THEORY)**

### ***Module I (15 hrs)***

#### **Immune system - 8 hrs**

Introduction to the immune system - historical perspective; types of immunity (innate and acquired); barriers of innate immunity – anatomic, physiologic, phagocytic, inflammatory; collaboration between innate and adaptive immunity; introduction to humoral and cell mediated immunity

#### **Cells and organs of the immune system - 7 hrs**

Cells (myeloid and lymphoid lineage); immune-reactive cells (macrophages, granulocytes, NK Cells); primary lymphoid organs (bone marrow and thymus); secondary lymphoid organs; (spleen, lymph nodes, GALT and MALT).

### ***Module II (15 hrs)***

#### **B cells and T cells - 4 hrs**

B-cells & T-cells – structure; function and significance; maturation, activation of B-cells & T-cells

#### **Antigen-antibody interactions - 8 hrs**

Introduction to antigens and antibodies; structure, types, classes, properties and variants (e.g. immunogens, antigens, haptens, adjuvants); paratope and epitope; antigen – antibody interaction; forces involved in antigen-antibody reaction; concept of affinity, avidity, precipitation, agglutination reactions; applications in diagnostics

#### **Complement system - 3 hrs**

The complement system; functions, components and activation pathways (classical, alternate and lectin)

### ***Module III (15 hrs)***

#### **MHC and Hypersensitivity - 5 hrs**

Major histocompatibility complex (MHC); introduction and discovery of human histocompatibility complex; structure of MHC I and II; presence of MHC I and II on different cells and their significance; hypersensitivity - Introduction

#### **Vaccines & monoclonal antibodies - 5 hrs**

Introduction to vaccines and types of vaccines; Polyclonal & Monoclonal antibodies (hybridoma technology)

#### **Autoimmunity and immunodeficiency - 5 hrs**

Introduction to autoimmunity with examples; introduction to immunodeficiency types with examples

**BIO-IV.C-6: IMMUNOLOGY (PRACTICAL)**

COURSE TITLE: IMMUNOLOGY (PRACTICAL)

COURSE CODE: BIO-IV.C-6

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

1. Study of lymphoid organs and cells of the Immune System
2. Total count of WBC & RBCs using haemocytometer
3. Differential count of WBC
4. Blood grouping & Rh factor
5. Preparation of serum
6. Single Radial Immuno-diffusion
7. Ouchterlony's double diffusion method and antibody titre calculation
8. Immuno-electrophoresis
9. ELISA (Demonstration)
10. Serological tests involving precipitations (Pregnancy & Widal)

**REFERENCES**

1. Arora, M.P. (2006). Cell Biology, Immunology and Environmental Biology, Himalaya Publishing House.
2. Richard A. Goldsby, Thomas J. Kindt, Barbara A. Osborne, Kuby, J (2007). Immunology, W.H. Freeman & Company, New York.
3. Rao, C.V. (2011). Immunology, Narosa Book Distributors Pvt. Ltd.
4. Roitt, I.M., Brostoff, J. & Male, D.K. (2012). Immunology, Mosby-Elsevier

**WEB REFERENCES**

5. <https://www.elsevier.com> > ... > Medicine > Immunology > Immunology
6. [http://www.himpub.com/BookDetail.aspx?BookId=1641&NB=&Book\\_TitleM=Cell%20Biology-Immunology%20and%20Environmental%20Biology](http://www.himpub.com/BookDetail.aspx?BookId=1641&NB=&Book_TitleM=Cell%20Biology-Immunology%20and%20Environmental%20Biology)
7. [https://www.roswellpark.org/sites/default/files/thanavala\\_9-4-14\\_innate\\_immunity\\_part\\_1.pdf](https://www.roswellpark.org/sites/default/files/thanavala_9-4-14_innate_immunity_part_1.pdf)
8. <https://www.elsevier.com> > ... > Veterinary Immunology

**BIO-IV.E-5: PLANT AND ANIMAL PHYSIOLOGY**

PAPER TITLE: PLANT AND ANIMAL PHYSIOLOGY (THEORY)

PAPER CODE: BIO-IV.E-5

MARKS: 75

CREDITS: 3

TOTAL HOURS: 45

PRE-REQUISITES: Completion of BIO-III.E-1- Basics of Plant and Animal Sciences

**Course Objectives**

The main aim of this paper is to introduce the students to the physiology of plant and animal systems with special emphasis on humans, thereby allowing them to understand how plant and animal systems function.

**Course Outcomes**

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

- CO1: Understand the physiological aspects of plants and animals.  
CO2: Explain the parts/organs and processes involved.  
CO3: Comprehend and distinguish between the organs and organs systems while understanding the biological functions associated with every system.  
CO4: Perform basic experiments like blood counts or checking pressure.  
CO5: Understand the effect of hormones on plant growth or assess the metabolites in the plant.

#### **BIO-IV.E-5: PLANT AND ANIMAL PHYSIOLOGY (THEORY)**

##### ***Module I (15 hrs)***

###### **Plant – Water Relations -3 hrs**

Absorption (passive and active); ascent of sap and transpiration

###### **Photosynthesis & photorespiration - 8 hrs**

Chloroplast pigments; photosystem I and II; electron flow through cyclic and non-cyclic; photophosphorylation; CO<sub>2</sub> fixation in C<sub>3</sub> and C<sub>4</sub> plants; CAM and glycolate pathways

###### **Physiology of flowering in angiosperms - 4 hrs**

Photoperiodism; vernalization and dormancy; molecular models of flowering: ABC model

##### ***Module II (15 hrs)***

###### **Plant hormones and regulation of plant growth - 4 hrs**

Hormonal; (auxin, cytokinin, gibberellins, ethylene and abscisic acid); regulation of plant growth and development)

###### **Secondary metabolites in plant - 3 hrs**

Classification of secondary metabolites and sources of: phenolics, porphyrins, terpenoids, alkaloids

###### **Digestive system- 3 hrs**

The digestive system and associated glands in mammals

###### **Muscular system - 2 hrs**

Introduction to the muscular system; types of muscles, muscle movement

###### **Excretory system - 3 hrs**

The excretory system and associated functions

##### ***Module III (15 hrs)***

###### **Respiration and circulation - 5 hrs**

The respiratory system – organs and their function; the circulatory system – components and their function

###### **Nervous system - 4 hrs**

The nervous system and associated functions

###### **Gametogenesis and reproductive physiology - 6 hrs**

Spermatogenesis and oogenesis; mammalian reproductive physiology – male and female reproductive system; an overview of developmental biology and regulatory mechanisms

#### **BIO-IV.E-5: PLANT AND ANIMAL PHYSIOLOGY (PRACTICAL)**

COURSE TITLE: PLANT AND ANIMAL PHYSIOLOGY (PRACTICAL)

COURSE CODE: BIO-IV.E-5

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

1. Study of the physiology of plants using charts
2. Study of the rate of photorespiration in plants
3. Study of osmosis: endosmosis and exosmosis in plants
4. Osmolarity of RBCs (Effect of different salt solutions of RBCs)
5. Isolation of Rhizobium from root nodules and Gram's staining
6. Qualitative phytochemical analysis in medicinal plants
7. Analysis of the animal physiology systems in man using charts – the reproductive, digestive, respiratory, circulatory, excretory, nervous and muscular systems.
8. Observation of permanent slides – Transverse section of mammalian gonads
9. Developmental stages in Frog (cleavage, blastula, gastrula)
10. Analysis of components of blood
11. Analysis of human blood pressure and pulse rate in man

## REFERENCES

### Plant physiology

1. Galston, A.W. (1989). Life Processes in Plants, Scientific American Library, Springer-Verlag., New York, USA.
2. Hopkins, W.G. (1995). Introduction to Plant Physiology, John Wiley & Sons, Inc., New York, USA.
3. Moore, T.C. (1989). Biochemistry and Physiology of Plant Hormones (Second edition), Springer-Verlag., New York.
4. Pandey, S.N., Mishra, S.P. & Trivedi, P.S. (1982), College Botany, Tata McGraw-Hill, New Delhi.

### Animal Physiology

5. Arora, M.P. (2011). Animal physiology, Himalaya publishing house.
6. Sembulingam, K. & Sembulingam, P. (2012). Essentials of Medical Physiology, Sixth edition., Jaypee brother's medical publishers (P) Ltd, New Delhi
7. Verma, S.K., Tyagi, A.K. & Agarwal, B.B.L. (2000). Animal Physiology, S. Chand and Company

## WEB REFERENCES

### Plant Physiology

1. <https://www.khanacademy.org/science/biology/photosynthesis-in-plants/the-calvin-cycle-reactions/a/calvin-cycle> (Calvin Cycle)
2. <http://ijpsr.com/bft-article/bioactivity-of-secondary-metabolites-of-various-plants-a-review/?view=fulltext> (Secondary Metabolites)
3. <https://www.khanacademy.org/science/biology/plant-biology/plant-responses-to-light-cues/a/phototropism-photoperiodism> (Photoperiodism)

### Animal Physiology

4. <https://www.ncbi.nlm.nih.gov/books/NBK442010/> (The Nervous System)
5. <https://www.youtube.com/watch?v=jmD0LBdAvIE> (The Nervous System)
6. <https://www.khanacademy.org/science/high-school-biology/hs-human-body-systems/hs-the-musculoskeletal-system/a/hs-the-musculoskeletal-system-review> (The Muscular System)

## **BIO-IV.E-6: TOOLS AND TECHNIQUES IN BIOTECHNOLOGY**

COURSE TITLE: TOOLS AND TECHNIQUES IN BIOTECHNOLOGY (THEORY)

COURSE CODE: BIO-IV.E-6

MARKS: 75

CREDITS: 3

TOTAL HOURS: 45

### **Course Objective**

This paper aims at introducing the importance of the basic concepts of instruments and their applications in the field of biotechnology.

### **Course Outcomes**

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

CO1: Explain the principle, types of centrifugation and their functions in biological sciences

CO2: Understand the basic differences between agarose electrophoresis, SDS and native PAGE

CO3: Explain the principle and applications of various spectroscopic and chromatographic techniques used in industries

CO4: Discuss radioactivity, radioactivity techniques used in biomedical research

CO5: Perform purification and separation of proteins.

## **BIO-IV.E-6: TOOLS AND TECHNIQUES IN BIOTECHNOLOGY (THEORY)**

### **Module I (15 hrs)**

#### **Basics of biochemical studies - 5 hrs**

Units of measurement; weak electrolytes - the biochemical importance of weak electrolytes; ionisation of weak acids and bases; calculation of pH; ionisation of a weak electrolyte; buffer solutions; buffer capacity; buffer action; measurement of pH

#### **Centrifugation - 5 hrs**

Principle of centrifugation; centrifugal force and sedimentation rate; preparative and analytical ultracentrifuges; differential and density gradient centrifugation

#### **Spectroscopy - 5 hrs**

Principle and technique of UV, Fluorescence, Infrared, Raman and AAS

### **Module II (15 hrs)**

#### **Chromatography - 7 hrs**

Principle and technique of: paper chromatography, TLC, gel filtration chromatography, ion exchange chromatography, affinity chromatography, HPLC, GLC

#### **Electrophoresis - 8 hrs**

Gel electrophoresis- agarose and PAGE (SDS and native); isoelectric focusing and 2D PAGE

### **Module III (15 hrs)**

#### **Probes and hybridization - 8 hrs**

Introduction to hybridization probes; radioactive and non-radioactive probes; FISH; southern; northern; western blotting and hybridization

#### **Radioisotopes techniques - 7 hrs**

Radiation – sources; types and applications of isotopes; radioactive decay – alpha, beta, gamma and x-rays; rate of radioactive decay and radioactive units; Geiger Muller counter and scintillation

#### **BIO-IV.E-6: TOOLS AND TECHNIQUES IN BIOTECHNOLOGY ( PRACTICAL)**

COURSE TITLE: TOOLS AND TECHNIQUES IN BIOTECHNOLOGY (PRACTICAL)

COURSE CODE: BIO-IV.E-6

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

1. Comparison of absorption curves of any two-coloured compounds
2. Isolation of plant chloroplasts by density gradient centrifugation
3. Preparation of TLC plates & separation of plant pigments
4. Gel filtration chromatography- Demonstration
5. Review of HPLC technique
6. Study of Atomic Absorption Spectroscopy
7. Dialysis of protein and SDS-PAGE
8. Southern blotting technique- Demonstration

#### **REFERENCES**

1. Mahesh, S. (2003) Biotechnology-3 Including Molecular Biology and Biophysics, New Age International Private Limited, Publishers New Delhi.
2. A rora , M.P. (2006) Biophysics, Himalaya Publishing House, New Delhi .
3. B ajpai , P. K. ( 2010). Biological Instrumentation and Methodology, Second Revised Edition. S. Chand and Company Limited.
4. Upadhyay, Upadhyay& NATH (2010) Biophysical Chemistry Principles and Techniques, Fourth Revised Edition, Himalaya Publishing House, New Delhi.
5. Sivasankar, B. (2009). Bioseparations Principles and Techniques, PHI Learning Private Limited, New Delhi.
6. Plummer, D.T. (1993). An Introduction to Practical Biochemistry, Sixth Reprint. Tata McGraw-Hill Publishing Company Limited, New Delhi.
7. Jayaraman, J. (2011). Laboratory Manual for Biotechnology, Second Edition. New Age International Private Limited, Publishers New Delhi.
8. Verma, A.S., Das, S. & Singh, A. (2014). Laboratory Manual for Biotechnology, First Edition, S. Chand and Company Private Limited.

#### **WEB REFERENCES**

9. <https://www.kopykitab.com> › Laboratory-Manual-For-Biotechnology-by-..
10. <https://www.sanfoundry.com> › analytical-instrumentation-questions-answer...
11. <https://www.miniphysics.com> › O Level › O Level Quiz
12. [wps.pearsoned.co.uk](https://wps.pearsoned.co.uk) › ema\_uk\_he\_housecroft\_chemistry\_4
13. <https://www.mcqsllearn.com/chemistry/spectrometer-multiple-choice-questions.php>

#### **BIO-IV.E-7: EVOLUTION AND ANTHROPOLOGY**

COURSE TITLE: EVOLUTION AND ANTHROPOLOGY (THEORY)

COURSE CODE: BIO-IV.E-7

MARKS: 75

CREDITS: 3



TOTAL HOURS: 45

### **Course Objective**

This paper aims at introducing the importance of the basic concepts of Evolution and anthropology and its importance in the field of biotechnology which will increase the awareness of the principles of human evolution and the biological adaptations that humans have made through time to various biotic and abiotic factors.

### **Course Outcomes**

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

CO1: Understand basic concepts of evolution and anthropology and importance in biotechnology

CO2: Explain the evolutionary history and describe the historical development of anthropology

CO3: Explain past and present cultures including ecological adaptations with scientific approach

CO4: Describe quantitative and qualitative methods in the analysis of anthropological data

CO5: Critically evaluate the logic of anthropological research and apply anthropological research to contemporary environmental, social, or health issues worldwide.

## **BIO-IV.E-7: EVOLUTION AND ANTHROPOLOGY (THEORY)**

### ***Module I (15 hrs)***

#### **Evolution of Life - 5 hrs**

Organic evolution; evidence; mechanism & theories; chemical evolution; biological evolution; types of Organic evolution

#### **Evolution of Species - 5 hrs**

Lamarckism; Darwinism; modern synthetic theory; mutational theory; introduction to molecular clock

#### **Evolution above the species level - 5 hrs**

Adaptive radiations with examples macroevolutions; microevolution; Simpson's adaptive grid; macroevolution

### ***Module II (15 hrs)***

#### **Speciation - 5 hrs**

Nature of Speciation; modes of speciation (instantaneous and gradual) ; types of barriers and isolation

#### **Selection 4 hrs**

Types – selection; natural selection (directional, disruptive, stabilizing) and artificial

#### **Fossils - 6 hrs**

Formation; conditions; nature and types of fossils; determination of age of rocks and fossils (carbon dating); evidence of evolution from fossils

### ***Module III (15 hrs)***

#### **Geographical and Geological Time Scale - 2 hrs**

An overview of the geographical and geological time scale

#### **Introduction to anthropology- 2 hrs**

Definition; areas and applications; relationship of biological anthropology with other sciences

#### **Evolution of Man - 6 hrs**

Phylogenetic status; characteristics and geographical distribution of the following: Homo erectus,

Neanderthal man, Rhodesian man, Homo sapiens

**The role of biotechnology in anthropology - 5 hrs**

Phylogenetic trees; mitochondrial DNA; Y chromosome analysis

**BIO-IV.E-7: EVOLUTION AND ANTHROPOLOGY (PRACTICAL)**

COURSE TITLE: EVOLUTION AND ANTHROPOLOGY (PRACTICAL)

COURSE CODE: BIO-IV.E-7

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

1. Study of the various theories of evolution
2. Evidence for Evolution - Study of Darwin's theory of evolution with examples
3. Evidence for Evolution - Study of L.S.B. Leakey's work in establishing human evolutionary development in Africa
4. Problems based on Selection
5. Study of genetic evolution across species
6. Construction of phylogenetic trees
7. Study of types of fossils
8. Study of dentition of different types of mammals – (Herbivores, Carnivores & Omnivores)
9. Visit to museum in Old Goa for anthropological studies
10. Comparative studies of pre-hominids and hominids
11. Comparative studies of haemoglobins

**REFERENCES**

1. B hasin M.K. & C hahal, S.M.S. (1996), Manual of Human Blood Analysis, Delhi.
2. Haviland. (2008). Introduction to Anthropology, Paperback.
3. Routledge & Paul, K. (1971), Notes and Queries in Anthropology, London.
4. Srivastava, V.K. (2004), Methodology and Fieldwork, Oxford.
5. Stanford, C., Allen, J.S. & Anton, S.C. (2009), Exploring Biological Anthropology: The Essentials, Prentice Hall.
6. Verma, P.S. and Agarwal, V.K. (2013). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, S. Chand & Company Private limited, New Delhi.

**WEB REFERENCES**

1. <https://www.livinganthropologically.com/biological-anthropology/> (Introduction to Anthropology and types)
2. <https://www.mcqslearn.com/anthropology/basics/quiz/quiz-questions-and-answers.php?> (Anthropological Studies and their applications)
3. <https://www.dk.com/us/book/9781465462558-dk-eyewitness-books-fossil/> (Examples on fossils and preservation methods)
4. <https://www.cambridge.org/core/books/genetics-paleontology-and-macroevo/91821199EF032AB6EA3A8FD03D> (Organic Evolution)
5. <https://www.mnn.com/earth-matters/animals/blogs/facts-about-lucy-australopithecine> (Fossils of *Australopithecus afarensis*)

## **BIO-IV.E-8: MOLECULAR GENETICS**

COURSE TITLE: MOLECULAR GENETICS (THEORY)

COURSE CODE: BIO-IV.E-8

MARKS: 75

CREDITS: 3

TOTAL HOURS: 45

PRE-REQUISITES: Completion of BIO-II.C-3 and BIO-III.C-5

### **Course Objective**

Having completed the two prerequisite courses – Fundamental Genetics and Molecular Biology, students will be able to apply their knowledge and skills to this paper. It focuses on various aspects of human genetics and explores the techniques and tools at the molecular level that can be used to identify them.

### **Course Outcomes**

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

CO1: Explain the methods of chromosome analysis and cell division

CO2: Understand the various molecular aspects of human genetics including DNA variation and mutations.

CO3: Apply their knowledge of various molecular techniques in order to diagnose specific genetic disorders.

CO4: Calculate the risk factors in genetic counselling for individuals with a family history of these disorders

CO5: Explain concepts in forensics genetics

## **BIO-IV.E-8: MOLECULAR GENETICS (THEORY)**

### **Module I (15 hrs)**

#### **Introduction - 2 hrs**

Introduction to molecular genetics – organization of a eukaryotic genome (human genome)

#### **Chromosomes and cell division - 9 hrs**

Classification and nomenclature of chromosomes; methods of chromosome analysis (chromosome banding techniques – G, R, Q, C and high-resolution banding); brief account of cell cycle; mitosis and meiosis; mechanisms of aneuploidy – nondisjunction; non-conjugation; anaphase lag; premature division of centromere; syndromes caused by aneuploidy – prevalence, causes and clinical features of Down's syndrome, Edward's syndrome and Patau syndrome; causes of polyploidy; structural abnormalities – reciprocal and Robertsonian translocations; Brief account of mosaicism and Chimerism

#### **Review of central dogma of molecular biology - 1 hr**

Brief review of the structure of DNA and replication, transcription and translation processes

#### **DNA Variation - 3 hrs**

Variation in DNA: genetic polymorphism; restriction Fragment Length Polymorphism (RFLP); short tandem repeat polymorphism (STR); variable number tandem repeat (VNTR)

### **Module II (15 hrs)**

#### **Techniques and tools in molecular biology - 8 hrs**

Techniques and Tools in Molecular Biology used in Genetic Diagnoses: genetic material studied for diagnosis– DNA, RNA and cDNA; DNA fragmentation and separation by electrophoresis and

membrane transfer; selective amplification of a nucleotide sequence using PCR; molecular hybridization techniques and applications: Labelled probes, fluorescence in situ hybridization (FISH), southern blot hybridization, dot blot and reverse dot blot, ARMS and OLA techniques, DNA microarrays.

#### **Genetic counselling - 7 hrs**

Screening (pre- and post-natal) for genetic abnormalities; establishing the diagnosis (family history and pedigree chart); calculation, presentation and quantification of risk (Bayesian determination of recurrent risks for genetic disorders within families); placing risks in context and discussion of options; patient support groups; directive and non-directive genetic counselling; special problems in genetic counselling

#### **Module III (15 hrs)**

##### **The Diagnosis of Inherited Diseases - 6 hrs**

Clinical description; molecular basis and genotype-phenotype correlation of: cystic fibrosis,  $\alpha$ -thalassemia and  $\beta$ -thalassemia, Duchenne Muscular dystrophy, Huntington's disease

##### **Gene Therapy - 3 hrs**

An overview of gene therapy and its applications in treating genetic disorders e.g. SCID

##### **Forensic genetics - 6 hrs**

Brief History; biological evidence – sources, collection, identification, characterization; DNA fingerprinting using PCR-based and non-PCR-based techniques

#### **BIO-IV.E-8: MOLECULAR GENETICS (PRACTICAL)**

COURSE TITLE: MOLECULAR GENETICS (PRACTICAL)

COURSE CODE: BIO-IV.E-8

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

1. Extraction of DNA from human blood and saliva
2. Visualization of extracted DNA on agarose gels
3. Principle of Southern blot
4. Study of diagnostic tools based on DNA polymorphisms
5. Principle of preparation of human metaphase chromosomes
6. Steps in molecular diagnosis of and further genetic counselling for:
  - a) Cystic fibrosis
  - b)  $\alpha$ -thalassemia and  $\beta$ -thalassemia
  - c) Duchenne muscular dystrophy
  - d) Huntington's disease
7. Risk calculation: using Bayes method for any two clinical case studies
8. Clinical features of Down's syndrome, Edward's syndrome and Patau syndrome and mechanisms leading to aneuploidy
9. Research: Current status of gene therapy for any two genetic disorders

#### **REFERENCES**

1. Goodwin, W., Linacre, A. & Hadid, S. (2007). An Introduction to Forensic Genetics, John Wiley & Sons, Ltd.

2. Pasternak, J.J. (2005). An Introduction to Human Molecular Genetics, Mechanisms of Inherited Diseases, Second Edition, John Wiley & Sons, Inc.
3. Serre, J.L. (2006). Diagnostic Techniques in Genetics, John Wiley & Sons, Ltd.
4. Turpenny, P. D. & Ellard, S. (2007). Emery's Elements of Medical Genetics, 13 th Edition, Churchill Livingstone Elsevier.

#### **WEB REFERENCES**

1. <https://www.lbwcc.edu/Content/Uploads/lbwcc.edu/files/Cell%20Division-Binary%20Fission%20and%20Mitosis%20Answered%20Review%20F%2007.pdf> (Mitosis)
2. <https://journals.plos.org/plosgenetics/article?id=10.1371/journal.pgen.1006960> (Forensic Genetics)
3. <https://www.annualreviews.org/doi/10.1146/annurev-med-012017-043332> (Gene Therapies)
4. <https://www.intechopen.com/books/genetic-diversity-and-disease-susceptibility/dna-polymorphisms-dna-based-molecular-markers-and-their-application-in-medicine> (Genetic Diversity)
5. <https://www.jove.com/science-education-library/2/basic-methods-in-cellular-and-molecular-biology> (Basic Methods in cellular and Molecular Biology)
6. <https://academic.oup.com/bmb/article/126/1/27/4958384> (Genetic Counselling)

### **Third Year B.Sc. Biotechnology Course Syllabus**

#### **BIO-V.C-7: CONCEPTS IN GENETIC ENGINEERING**

COURSE TITLE: CONCEPTS IN GENETIC ENGINEERING (THEORY)

COURSE CODE: BIO-V.C-7

MARKS: 75

CREDITS: 3

TOTAL HOURS: 45

PRE-REQUISITES: Completion of BIO-III.C-5- Molecular Biology

#### **Course Objective**

The course aims to introduce the students to the principles and techniques involved in Genetic Engineering through the use of genetic material and vehicles for suitable manipulation of genes.

#### **Course Outcomes**

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

CO1: understand the functions of several enzymes and vectors used in cloning.

CO2: acquaint to the versatile tools and techniques employed in recombinant DNA technology.

CO3: Explain the construction of DNA & c DNA library

CO4: Procure skills for selection of recombinants

CO5: Acquire skills on techniques of plasmid isolation

#### **BIO-V.C-7: CONCEPTS IN GENETIC ENGINEERING (THEORY)**

##### ***Module I (15 hrs)***

##### **Introduction to genetic engineering - 2 hrs**

Aims; principles; applications; ethical issues involving recombinant DNA technology and genetic engineering

**DNA modifying enzymes - 3 hrs**

Nucleases - endonucleases (restriction enzymes recognition sequences, cleavage pattern); exonucleases; DNA ligases; reverse transcriptase; polynucleotide kinases; alkaline phosphatases; nucleotidyl-transferases

**Vehicles for gene cloning - 10 hrs**

Vectors - properties of ideal cloning vectors; plasmids – properties, classification; Vector for Prokaryotes - pBR322, pUC 18 ; bacteriophages as cloning vectors - lambda bacteriophages; features-insertional vectors and replacement vectors & M13 Bacteriophage; cosmids, phagemids and phasmids- definition, features with examples; vectors for cloning in *Saccharomyces cerevisiae* (examples and features); shuttle vectors - any one example; vectors for plant – *Ti* plasmid

**Module II (15 hrs)****DNA insertion into vector - 3 hrs**

Ligation; linkers; adaptors, homopolymer tailing

**Transformation methods - 8 hrs**

Methods, advantages and disadvantages: competence (transformation in bacteria); microinjection; lipofection; electroporation; macro-injection; sonication; silicon carbide fibre; vortex; DNA co precipitation; ultrasonication; laser induced; *Agrobacterium* mediated transfers

**Identification of recombinants - 4 hrs**

Principle and importance of identification of recombinants; antibiotic resistance (amp, tet-resistance); lacZ selection; colony hybridization; *cI* selection

**Module III (15 hrs)****DNA isolation methods and analysis - 5 hrs**

Isolation of genomic DNA & plasmid DNA; principle of plasmid isolation; spectrophotometric analysis of DNA; agarose gel electrophoresis; purification of DNA

**Amplification of nucleotide sequences - 3 hrs**

Polymerase chain reaction (principles, components & method of PCR)

**DNA sequencing - 5 hrs**

Significance and importance of DNA sequencing; Maxam Gilbert's method, Sanger's method, Automatic DNA sequencer

**Genomic / cDNA libraries - 2 hrs**

Preparation of genomic library; cDNA library; Screening of libraries

**BIO-V.C-7: CONCEPTS IN GENETIC ENGINEERING (PRACTICAL)**

COURSE TITLE: CONCEPTS IN GENETIC ENGINEERING (PRACTICAL)

COURSE CODE: BIO-V.C-7

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

1. Plasmid DNA isolation by alkaline lysis method
2. Plasmid DNA isolation by boiling method
3. Plasmid DNA separation on agarose gel
4. Molecular size determination of the plasmid
5. Preparation of competent cells in bacteria

6. Transformation in bacteria using suitable plasmid (pUC 18)
7. Selection of transformed colonies
8. Deciphering the DNA sequence from a sequencing gel photograph by Maxam and Gilbert's method and Sanger's method
9. Demonstration of Polymerase Chain Reaction (PCR)

## REFERENCES

1. Brown, T.A. (2006) Manipulation of purified DNA. In: Gene cloning & DNA analysis An Introduction, 5th Ed. Blackwell publishing, Ltd, UK
2. Jogdand, S.N. (2008). Gene Biotechnology, 2 nd edition, Himalaya Publishing House, Mumbai.
3. Primrose, S.B. & Twyman, R.M. (2009). Principles of Gene Manipulation and Genomics, Blackwell Publishing.
4. Purohit, S.S. (2009). Biotechnology: Fundamentals and Applications, Student Edition.
5. Singh, B.D. (2008). Biotechnology: Expanding Horizons, Kalyani publishers.
6. Verma P.S and Agarwal V.K. (2009). Genetic Engineering, S. Chand & Company LTD, Delhi.
7. Watson, J.D., Tooze, J. & Kurtz, D.T. (1983). Recombinant DNA: A short Course, Scientific American Books (WH Freeman), New York.

## WEB REFERENCES

1. <https://www.khanacademy.org/science/ap-biology/gene-expression-and-regulation/biotechnology/v/dna-sequencing> (DNA sequencing)
2. <https://www.khanacademy.org/science/high-school-biology/hs-molecular-genetics/hs-biotechnology/v/the-polymerase-chain-reaction-pcr> (PCR)
3. <https://www.khanacademy.org/science/biology/biotech-dna-technology/dna-cloning-tutorial/a/bacterial-transformation-selection> (Transformation in bacteria using pUC 18)

## BIO-V.E-9 MOLECULAR MEDICINE

COURSE TITLE: MOLECULAR MEDICINE (THEORY)

COURSE CODE: BIO-V.E-9

MARKS: 75

CREDITS: 3

TOTAL HOURS: 45

PRE-REQUISITES: Completion of BIO-IV.E-8 -Molecular Genetics

### Course Objective

Molecular medicine is the application of molecular biology and molecular genetics to the understanding of human health and disease. It aims to understand the underlying origins and mechanisms of human diseases and to find novel ways of preventing, diagnosing and treating diseases

### Course Outcomes

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

CO1: Understand the historical aspects of molecular medicine

CO2: Understand the underlying genetic factors of common diseases

CO3: Describe molecular and cellular therapies for the same

CO4: Gain a basic knowledge on cancer genetics and pharmaco-genetics

CO5: Understand the importance of maintaining public health

## **BIO-V.E-9 MOLECULAR MEDICINE (THEORY)**

### ***Module I (15 hrs)***

#### **Historical aspects - 2 hrs**

History of molecular medicine – foundations (1869 – 1980s); the modern era (1980s – 2000s); The Human Genome project (1990 – 2000)

#### **Gene structure and expression - 3 hrs**

Exons, introns, alternative splicing, epigenetic changes

#### **Genetic factors in common diseases - 6 hrs**

Hypertension; coronary heart disease; autism; Alzheimer disease; haemochromatosis; age-related macular degeneration

#### **Complex genetic traits - 4 hrs**

Multifactorial disorders – diabetes, dementia, schizophrenia; novel mechanisms for DNA and disease – mitochondrial inheritance, genomic imprinting, mosaicism, chimerism

### ***Module II (15 hrs)***

#### **Cancer genetics - 5 hrs**

Differentiation between genetic and environmental factors in cancer; oncogenes – types and function; tumour-suppressor genes – “two hit hypotheses”; genetics of common cancers – breast, ovarian and prostate cancer

#### **Introduction to Omics - 3 hrs**

Genomics, Proteomics, Metabolomics, Phenomics, Metagenomics

#### **DNA Tests - 4 hrs**

Direct Detection; indirect detection - DNA scanning; linkage analysis; classes of DNA tests and function of each type; validity of DNA tests

#### **Delivering genetics and genomics to consumers - 3 hrs**

Definitions, marketplace, types of direct-to-consumer (DTC) DNA tests; Pros & Cons of DTC DNA Tests

### ***Module III (15 hrs)***

#### **Molecular and cellular therapies - 8 hrs**

Recombinant DNA products – Factor VIII (Haemophilia); vaccines; somatic cell gene therapy; examples of gene therapy trials – ADA, haemophilia, cancer, eye disease, HIV; RNA therapies – RNA interference (RNAi), ribozymes; regenerative medicine – cloning, stem cells.

#### **Pharmacogenetics - 3 hrs**

Drug metabolism; genetic variations revealed by effects of drugs; pharmacogenetics– maturity-onset diabetes of the young (MODY); neonatal diabetes; pharmacogenomics; adverse effects; Efficacy

#### **Public health - 4 hrs**

Preventive medicine; population screening (cystic fibrosis, sickle cell anaemia, newborn screening); changing behaviour (familial hypercholesterolemia); DNA testing in the workplace – predisposition to disease; detecting exposure to toxins; litigation, identity

## **BIO-V.E-9: MOLECULAR MEDICINE (PRACTICAL)**

COURSE TITLE: MOLECULAR MEDICINE (PRACTICAL)

COURSE CODE: BIO-V.E-9



MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

1. Investigation of Genetic Factors in any four common diseases
2. Study of mitochondrial inheritance, genomic imprinting, mosaicism and chimerism with one example of each
3. A study on the types of DNA tests for diagnosis of diseases
4. Investigation of Molecular Mechanisms of any one type of Cancer
5. Understanding concepts relating to genomics and proteomics
6. A study on RNA therapies and regenerative medicine
7. Application of pharmacogenetics in drug metabolism
8. An investigation into the screening programmes adopted in various countries
9. Submission of a report on the molecular mechanisms and therapy for any one disease

### REFERENCES

1. Trent, R.J. (2005). Molecular Medicine – an Introductory Text, Elsevier Academic Press.
2. Trent, R.J. (2012). Molecular Medicine – Genomics to Personalized Health Care, Fourth Edition, Elsevier Inc.
3. Turnpenny, P.D. & Ellard, S. (2007). Emery's Elements of Medical Genetics, 13<sup>th</sup> Edition, Churchill Livingstone Elsevier.

### WEB REFERENCES

1. <https://www.khanacademy.org/science/biology/gene-regulation/gene-regulation-in-eukaryotes/a/overview-of-eukaryotic-gene-regulation> (Eukaryotic gene expression)
2. <https://onlinelibrary.wiley.com/doi/abs/10.1002/bies.201400138> (Eukaryotic gene expression)
3. <https://onlinelibrary.wiley.com/doi/full/10.1002/wrna.1276> (Alternative splicing)
4. <http://journals.tubitak.gov.tr/medical/issues/sag-15-45-5/sag-45-5-3-1406-146.pdf> (genetic factors in Alzheimer's disease and age-related macular degeneration)
5. <https://www.spandidos-publications.com/br/7/2/105> (genetic factors in Alzheimer's disease)
6. <https://www.sciencedirect.com/science/article/pii/S014067361501315X> (genetic factors in hemochromatosis)
7. <https://link.springer.com/article/10.1007/s10815-017-0895-5> (Genomic imprinting)
8. <https://www.sciencedirect.com/science/article/abs/pii/S0168952515000669> (Mosaicism review)
9. <https://www.sciencedirect.com/science/article/abs/pii/S0090825817300744> (Cancer genetics)
10. <https://www.nature.com/articles/nrg.2018.4> (Omics)
11. <https://www.nature.com/articles/nrg3908> (DNA testing Linkage analysis)
12. <https://onlinelibrary.wiley.com/doi/abs/10.1002/ajmg.c.31390> (Pharmacogenetics)

### BIO-V.E-10: ENVIRONMENTAL BIOTECHNOLOGY

COURSE TITLE: ENVIRONMENTAL BIOTECHNOLOGY (THEORY)

COURSE CODE: BIO-V.E-10

MARKS: 75

CREDITS: 3

TOTAL HOURS: 45

## **Course Objective**

The main aim of this course is to introduce the students to the hazards of our environment, the effects of pollution on living systems, solutions to protect the environment for sustainable development.

## **Course Outcomes**

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

CO1: Explain the scope of Environmental Biotechnology.

CO2: Understand the basic ecological concepts, various pollution, its measurements & remediation.

CO3: Describe the various eco-friendly bio-products.

CO4: Assess the quality of the water sample through various parameters like MPN test, dissolved oxygen concentration, biological oxygen demand, chemical oxygen demand and nitrates of water sample.

CO5: Understand the working of sewage treatment plant.

## **BIO-V.E-10: ENVIRONMENTAL BIOTECHNOLOGY (THEORY)**

### ***Module I (15 hrs)***

#### **Basic ecological concepts and principles - 3 hrs**

Structure (biotic and abiotic components); food chains and food webs; ecological pyramids; productivity and eco-energetic (10% law)

#### **Anthropogenic activities, its effects and control - 12 hrs**

Air pollution: Major air pollutants and their sources, Impacts of air pollution on human health, animals, plants and climate; removal of gaseous contaminants and odour: bio scrubbers, bio trickling filters and biofilters/ bio beds

Water pollution: Principal forms of water pollutants and their sources; wastewater treatment: activated sludge process, rotating biological discs, oxidation ponds, trickling filters

Soil pollution: Soil pollution and their sources; treatment of solid wastes: hazardous; non-hazardous; composting and vermi-technology

### ***Module II (15 hrs)***

#### **Pollution monitoring - 10 hrs**

Bio indicators: concept and examples (indicators of water quality; air pollution indicators); choice of criteria: visual rating; genotoxicity; metabolic rating; applications (two each); using plant test systems and animal test systems; tests for assessing Genetic damage: AMES test; cytogenetic assay; membrane damage; concept and applications of molecular biology in environmental monitoring: reporter gene: concept and applications of biosensors in pollution detection

#### **Pollution abatement: Bioremediation - 5 hrs**

Bioremediation: definition, microbial bioremediation, phytoremediation; microbial desulphurization of coal (direct and indirect mechanisms)

### ***Module III (15 hrs)***

#### **Pollution abatement: biodegradation - 6 hrs**

Biodegradation: basis of biodegradation, concepts of use of mixed microbial populations; Biodegradation of two xenobiotics: aromatic hydrocarbons (benzene) and alkanes Biosorption: principle; use of fungi and algae (2 examples each); genetically engineered microorganisms - superbug (*Pseudomonas* sp.)

**Eco-friendly Bio-products - 7 hrs**

Biogas (bio-methanization) production; bioethanol production; bio hydrogen production: anaerobic bacteria and photolysis photosynthetic algae; biodiesel production; bioplastics: bio-pol and bio-lac; biopesticide

**Scope of environmental biotechnology - 2 hrs**

Scope of environmental biotechnology

**BIO-V.E-10: ENVIRONMENTAL BIOTECHNOLOGY ( PRACTICAL)**

COURSE TITLE: ENVIRONMENTAL BIOTECHNOLOGY (PRACTICAL)

COURSE CODE: BIO-V.E-10

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

1. Determination of dissolved oxygen concentration of water sample by Winkler's method
2. Determination of biological oxygen demand (BOD) of the given sample
3. Determination of chemical oxygen demand (COD) of the given sample ( $\text{KMnO}_4$  /  $\text{K}_2\text{Cr}_2\text{O}_7$  method)
4. Determination of TS (total solids) of the given water sample
5. Isolation of xenobiotic degrading bacteria by selective enrichment
6. Determination of nitrates from water sample
7. Visit to an effluent /sewage treatment plant and preparation of report
8. Detection of coliforms for determination of the purity of potable water (MPN, Presumptive, confirmatory and confirmed tests)

**REFERENCES**

1. Agarwal S.K. (2009). Environmental Biotechnology, APH Publishing Corporation New Delhi.
2. Anjaneyulu Y. (2005). Introduction to environmental Science, BS publications, India.
3. Chatterji A.K. (2009). Introduction to Environmental Biotechnology, 2nd ed, Prentice Hall of India Pvt. Ltd. New Delhi.
4. Jogdand B.N. (2008). Environmental Biotechnology (Industrial Pollution Management), Himalaya Publishing House, Mumbai.
5. Santra S.C. (2001). Environmental Science, New central book agency (P) Ltd. Calcutta.
6. Singh B.D. (2008). Biotechnology, 3 rd edition, Kalyani Publishers.
7. Thakur I.S. (2006). Environmental Biotechnology: Basic concepts and applications, I.K. International Pvt. Ltd. New Delhi.

**WEB REFERENCES**

1. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2781844/> (Anthropogenic activities and its effects)
2. <https://www.khanacademy.org/science/high-school-biology/hs-ecology/hs-human-impact-on-ecosystems/a/hs-human-impact-on-ecosystems-review> (Anthropogenic activities and its effects)
3. <https://www.sciencedirect.com/book/9780128000212/microbial-biodegradation-and-bioremediation> (Anthropogenic activities and its effects)
4. <https://www.intechopen.com/books/biodegradation-life-of-science/biodegradation-involved-microorganisms-and-genetically-engineered-microorganisms> (Bioremediation & biodegradation)

5. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4463667/> (Bioremediation & biodegradation)
6. <https://www.intechopen.com/books/biofuels-state-of-development/prospective-biodegradable-plastics-from-biomass-conversion-processes> (Eco-friendly Bio-products)
7. <https://www.epa.gov/ingredients-used-pesticide-products/what-are-biopesticides> (Eco-friendly Bio-products)
8. <https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/biopesticide> (Eco-friendly Bio-products)

## **BIO-V.E-11: PLANT BIOTECHNOLOGY**

COURSE TITLE: PLANT BIOTECHNOLOGY (THEORY)

COURSE CODE: BIO-V.E-11

MARKS: 75

CREDITS: 3

TOTAL HOURS: 45

### **Course Objective**

This course aims at introducing the concept of in vitro culture of plants including set up of a plant tissue culture laboratory, instruments and sterilization techniques. This course will help the students to understand that various parts of the plant may be cultured, with each type of culture having specific applications. Plant tissue culture also lends itself for production of transgenic plants which have various applications.

### **Course outcomes**

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

CO1: This paper aims at introducing the concept of in vitro culture of plants including set up of a plant tissue culture laboratory, instruments and sterilization techniques.

CO2: This paper will help the students to understand that various parts of the plant may be cultured, with each type of culture having specific applications.

CO3: Plant tissue culture also lends itself for production of transgenic plants which have various applications.

CO4: On completion of this module, the student will be able to understand all about plant biotechnology in terms of set up of a laboratory, culture of explants

CO5: In addition, the students will be able to understand genetic engineering methods for production of transgenic plants.

## **BIO-V.E-11: PLANT BIOTECHNOLOGY (THEORY)**

### **Module I (15 hrs)**

#### **History of plant tissue culture - 2 hrs**

International and Indian scientists

#### **Laboratory organization - 4 hrs**

Washing and drying facility; general laboratory and media preparation area; transfer area; culture room; growth chambers and green house (ideal conditions for incubation and maintenance of cultures/plants).

#### **Sterilization techniques - 2 hrs**

Sterilization techniques used in plant tissue culture – steam, dry, filter, ultra violet, alcohol, flame and chemical (explants)

#### **Plant tissue culture media - 4 hrs**

Major and minor inorganic nutrients; vitamins; carbon source; hormones; complex organic additives and their functions; composition of some commonly used plant tissue culture media – MS, White's, Nitsch, Gamborg's B5

#### **Totipotency - 2 hrs**

Totipotency and its Importance; Various parts of the plant serving as Explants

#### **Organogenesis - 1 hr**

Root and shoot regeneration and applications

### **Module II (15 hrs)**

#### **Organ culture and its applications - 5 hrs**

Root; shoot tip/meristem; anther and pollen; ovary and ovule embryo

#### **Callus and cell suspension cultures - 4 hrs**

Callus culture – principle; characteristics of callus tissue; applications; cell suspension culture – principle; isolation; growth patterns; concept of batch and continuous culture; viability testing

#### **Soma clonal variation - 2 hrs**

Concept; isolation of variants; mechanisms of soma clonal variation and applications

#### **Somatic embryogenesis and artificial seeds - 2 hrs**

Somatic embryogenesis – principle; procedure and applications; artificial seeds – methods of production and applications

#### **Applications of Tissue Culture in Plant Sciences - 2 hrs**

Micropropagation; gene conservation banks; forestry

### **Module III (15 hrs)**

#### **Protoplast culture and somatic hybridization - 4 hrs**

Protoplast culture – principle; isolation of protoplasts (mechanical and enzymatic); methods of culture; checking viability; somatic hybridization - protoplast fusion (spontaneous and induced); selection of hybrid protoplasts; applications of somatic hybridization

#### **Production of secondary metabolites - 2 hrs**

Classification of secondary metabolites with examples; production using culture methods - callus culture; cell suspension culture; hairy root culture (*A. rhizogenes*); immobilized cell systems

#### **Gene transfer in plants - 4 hrs**

Introduction to *Agrobacterium tumefaciens* and *Ti* plasmid; *Agrobacterium* based vectors (cointegrate and binary vectors); co-culture method and in plant transformation; direct methods of gene transfer – electroporation, chemical methods, particle gun method and microinjection

#### **Applications of transgenic plants - 5 hrs**

Insect resistance (BT toxin); drought and salt tolerance; herbicide resistance; increasing shelf life of fruits; improvement of vitamin content (golden rice) and edible vaccines

### **BIO-V.E-11: PLANT BIOTECHNOLOGY (PRACTICAL)**

COURSE TITLE: PLANT BIOTECHNOLOGY (PRACTICAL)

COURSE CODE: BIO-V.E-11

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

1. Washing, Packing and Sterilization of Glassware

2. Preparation of Stock solutions for Murashige and Skoog (MS) medium
3. Preparation, sterilization and pouring of MS medium
4. Aseptic germination of seedling
5. Callus induction from hypocotyl and carrot cambial explants and subculturing
6. Shoot tip culture
7. Regeneration of shoot/root from callus
8. Setting up of cell suspension culture and checking viability by Evan's blue method
9. Setting up an in vitro culture from seed embryo (embryo culture)
10. Encapsulation of somatic/true embryo (synthetic seeds) and Regeneration of Plants from Synthetic Seeds

## REFERENCES

1. Chawla, H.S. (2002) Introduction to Plant Biotechnology, Science Publishers Inc. USA.
2. De, K.K. (2008) Plant Tissue Culture, New Central Book Agency Pvt. Ltd.
3. Jha, T.B. & Ghosh, B. (2005) Plant Tissue Culture, University Press (India) Pvt. Ltd.
4. Singh, B.D. (2005) Plant Biotechnology, Kalyani Publishers.

## WEB REFERENCES

1. <https://www.sciencedirect.com/science/article/abs/pii/S0140196301908845> (Tissue culture technology)
2. [https://www.researchgate.net/publication/272493719\\_Plant\\_Cell\\_Tissue\\_and\\_Organ\\_Culture\\_Biotechnology\\_and\\_Its\\_Application\\_in\\_Medicinal\\_and\\_Aromatic\\_Plants](https://www.researchgate.net/publication/272493719_Plant_Cell_Tissue_and_Organ_Culture_Biotechnology_and_Its_Application_in_Medicinal_and_Aromatic_Plants) (organ culture)
3. <https://link.springer.com/article/10.1007/BF02632054> (transgenic plants)
4. <https://www.nature.com/articles/nbt0188-56> (protoplast culture)
5. [https://link.springer.com/chapter/10.1007/978-981-10-2961-5\\_2](https://link.springer.com/chapter/10.1007/978-981-10-2961-5_2) (applications)

## BIO-V.E-12: BIOINFORMATICS

COURSE TITLE: BIOINFORMATICS (THEORY)

COURSE CODE: BIO-V.E-12

MARKS: 75

CREDITS: 3

TOTAL HOURS: 45

### Course Objective

This Course aims at introducing the importance of the basics of computers, concept of Human Genome Project, storage of biological information and tools and techniques of bioinformatics used and their importance in the field of biotechnology.

### Course Outcomes

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

CO1: Explain the scope of Bioinformatics

CO2: Understand the basic concept of biological databases, various types and applications of biological databases.

CO3: Describe the various applications of BLAST and FASTA in understanding differences in evolutionary patterns

CO4: Assess the mutations, genetic disorders and understand importance of drug design *In silico*

CO5: Will be able to construct evolution tree, cladogram, retrieve and biological information accessed through various information resources.

## **BIO-V.E-12: BIOINFORMATICS (THEORY)**

### ***Module I (15 hrs)***

#### **Introduction to Computers in Biology - 3 hrs**

Introduction to use of computers, internet and software in biology; Role of computers in medicine and research

#### **DNA, RNA and Proteins and HGP - 5 hrs**

Background of DNA, RNA and Proteins, ORF; Review of transcription and translation; Introduction to HGP; objectives; achievements of HGP; Ethical and Social issues

#### **Introduction to bioinformatics - 3 hrs**

Definition; scope of bioinformatics; bioinformatics vs computational biology; components of bioinformatics and applications

#### **Information resources - 4 hrs**

Introduction and objectives of NCBI, NLM, NIH, EBI and SRS

### ***Module II (15 hrs)***

#### **Biological databases - 7 hrs**

Types of data and biological databases; Primary databases: GenBank, EMBL, DDBJ; Secondary databases: Swiss-PROT, PDB & PIR; Composite databases: OWL & PROSITE

#### **Structural databases - 5 hrs**

X-ray crystallography, PDB, MMDB, CATH, SCOP; Visualization of proteins -Cn3D & Rasmol

#### **Literature databases - 3 hrs**

PubMed; Medline and OMIM

### ***Module III (15 hrs)***

#### **BLAST and FASTA - 4 hrs**

Introduction to BLAST and FASTA and their types

#### **Sequence alignment tools - 6 hrs**

Sequence alignment - Pairwise and Multiple; Clustal-W Omega; T-coffee

#### **Phylogeny - 5 hrs**

Introduction to phylogeny and cladistics; Cladogram and Phylogenetic tree construction; structure and types of phylogenetic trees; differences between cladogram and phylogenetic tree; Applications of phylogeny.

## **BIO-V.E-12: BIOINFORMATICS ( PRACTICAL)**

COURSE TITLE: BIOINFORMATICS (PRACTICAL)

COURSE CODE: BIO-V.E-12

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

1. Introduction to Bioinformatics & its Applications
2. Study of Human Genome Project
3. Usage of NCBI resources
4. Biological data search using NCBI – Protein or amino acid sequences
5. Biological data search using NCBI – DNA or gene sequences

6. Biological data search using NCBI – Literature & Structure databases
7. Database search & Pairwise sequence alignment using NCBI BLAST: BLASTp & BLASTn
8. Multiple sequence alignment using Clustal-W
9. Construction of phylogenetic tree using Clustal-W
10. DNA sequence analysis to find restriction enzymes sites using NEBcutter
11. Visualization of protein structures using Cn3D/ Rasmol

## REFERENCES

1. Harisha, S. (2007). Fundamentals of Bioinformatics, I. K. International Publishing House, Mumbai.
2. Ignacimuthu, S. (2005). Basic Bioinformatics, Narosa Publishing House, New Delhi.
3. Mount, D.W. (2004). Bioinformatics – sequence and Genome analysis, CBS Publishers.
4. Murthy, C.S.V. (2003). Bioinformatics, Himalaya Publishing House, Mumbai.
5. Rastogi, S.C., Mendiratta, N. & Rastogi, P. (2004). Bioinformatics: Concepts, Skills and Applications, CBS Publishers.
6. Xiong, J. (2006). Essential Bioinformatics, Cambridge University Press.

## WEB REFERENCES

1. [www.ncbi.nlm.nih.gov](http://www.ncbi.nlm.nih.gov) (NCBI resources)
2. [www.pellegrini.mcdub.ucla.edu > wp-content > uploads > sites > 2017/07](http://www.pellegrini.mcdub.ucla.edu/wp-content/uploads/sites/2017/07) (Phylogenetic tree construction)
3. <https://vlab.amrita.edu/?sub=3&brch=273&sim=1432&cnt=1> (Phylogenetic tree construction)
4. <https://www.ck12.org/biology/phylogeny-and-cladistics/lesson/Cladistics-Advanced-BIO-ADV/> (Phylogeny and Cladistics)
5. <https://science.jrank.org/pages/5210/Phylogeny/> (Phylogeny and Cladistics)
6. <https://pediaa.com/difference-between-cladogram-and-phylogenetic-tree/> (Phylogeny and Cladistics)
7. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1186895/> (X-ray crystallography and protein structure determination)

## BIO-VI.C-8: INDUSTRIAL BIOTECHNOLOGY

COURSE TITLE: INDUSTRIAL BIOTECHNOLOGY (THEORY)

COURSE CODE: BIO-VI.C-8

MARKS: 75

CREDITS: 3

TOTAL HOURS: 45

PRE-REQUISITES: Completion of BIO-II.C-4-Basic Microbiology

### Course Objective

This course is designed to introduce the students to the basic concepts in Industrial Biotechnology. The paper covers concepts in Industrial Biotechnology, mainly introducing the basics of upstream processes in fermentation technology on an industrial scale.

### Course Outcomes

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

CO1: Understand and explain various features of a fermenter.

CO2: Comprehend various concepts of Upstream and Downstream processes.



CO3: Describe the production processes of fermentation products like wine or vinegar at the industrial level.

CO4: Design small scale experiments to produce common enzymes like amylase.

CO5: Prepare basic fermentation products like wine, vinegar, etc.

## **BIO-VI.C-8: INDUSTRIAL BIOTECHNOLOGY (THEORY)**

### ***Module I (15 hrs)***

#### **Fermentation equipment and its use - 10 hrs**

Definition of fermenter/bioreactors; structure of ideal fermenter; definition and uses of impellers and their types; sparger's and their types; baffles; headspace ; controls and sensors (temperature, pH, antifoam, dissolved oxygen and carbon dioxide sensor) ; types of reactors (definition, description, diagram and uses)-stirred tank reactors; bubble columns; airlift bioreactors (internal and external loop); fluidised bed; packed bed column, photobioreactors; tray bioreactors

#### **Screening and selection of microorganisms - 3 hrs**

Primary screening-definition; techniques; crowded Plate; auxanography; enrichment; indicator dye; secondary screening- definition and features; giant colony technique

#### **Stock cultures - 2 hrs**

Cryogenic preservation; aims of preservation of cultures; definition of working and primary stock cultures; techniques of preservation- serial subculture, sterile soil, water, silica gel; sterile mineral oil; lyophilisation

### ***Module II (15 hrs)***

#### **Types of fermentation processes - 3 hrs**

Continuous; submerged; surface/solid state; batch; fed-batch

#### **Fermentation media - 5 hrs**

Characteristics of an ideal; production media; media composition – crude, synthetic; media; sterilization -Heat, radiation, chemical methods and filtration; batch and continuous sterilization, inoculum preparation

#### **Detection and assay of fermentation products - 5 hrs**

Physical or chemical assay- titration and gravimetric assay; turbidity analysis, cell determination; spectrophotometric assay; chromatographic partition assay; biological assay-concept benefits and drawbacks; diffusion assay; turbidimetric and growth assay; end point assay; metabolic response assay; enzymatic assay

#### **Scale up of fermentations and increasing product yields - 2 hrs**

Significance of scale up; pilot fermenters; increasing product yields by mutagens-physical and chemical mutagens/strain improvement

### ***Module III (15 hrs)***

#### **Downstream processing - 10 hrs**

Biomass: separation of cells – flocculation; floatation; filter aids and filtration (surface, depth); centrifugation- batch centrifuge Ex: tubular bowl centrifuge; continuous centrifuge Ex: Basket centrifuge; disintegration in brief: mechanical Ex: ultrasonication; homogenisers and use of ballotine; non mechanical Ex: thermal lysis; chemical detergent solubilisation, organic solvents; enzymatic methods Ex: Lysozyme

Broth: Enrichment: evaporation, membrane filtration, liquid-liquid extraction, precipitation, adsorption

Purification: chromatography

Formulation - crystallization and drying (convection drying Ex: spray dryers, freeze drying)

### **Industrial production - 5 hrs**

Organisms; fermentation media and conditions; downstream processing and uses -alcohol /Wine; penicillin, vinegar

## **BIO-VI.C-8: INDUSTRIAL BIOTECHNOLOGY (PRACTICAL)**

COURSE TITLE: INDUSTRIAL BIOTECHNOLOGY (PRACTICAL)

COURSE CODE: BIO-VI.C-8

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

1. A study on the phases of growth of microorganisms during batch fermentation (equipment: Erlenmeyer flask, medium: nutrient broth, inoculum: *E. coli*).
2. Parts of a fermenter
3. Preparation and sterilization of medium for batch fermentation process
4. Batch fermentation using fermenter
5. Preparation and sterilization of medium for fed-batch fermentation process
6. Fed-batch fermentation
7. Decontamination and sterilization of the fermenter
8. Primary screening of antibiotic producing bacteria by crowded plate technique
9. Secondary screening for antibiotic producers by Giant Colony Technique
10. Production of wine (from pineapple or any other fruit/vegetable) using yeast
11. Production of vinegar from toddy
12. Estimation of total reducing sugars and acidity (total and volatile) in wine and vinegar (before and after fermentation)

## **REFERENCES**

1. Casida L.E. (2009). Industrial Microbiology, New Age International (P) Ltd. New Delhi.
2. Patel A.H. (2012). Industrial Microbiology, MacMillan Publishers India Ltd.
3. Prescott & Dunn. (1982). Industrial Microbiology, 4th edition, AVI Publishing Co.
4. Rutledge C. & Kristiansen B. (2001). Basic Biotechnology, 2nd edition. Cambridge press.
5. Stanbury P. F, Whitaker A. & Hall. (1997). Principles of fermentation technology, 2nd Edition, Aditya Books Pvt. Ltd, New Delhi.
6. WulfCruger and Anneliese Cruger, A Textbook of Industrial Microbiology. 2007. Sinauer associates pub.
7. Prave P., Faust U., Sitting W., Sukatsch D.A., Fundamentals of Biotechnology. 2004. VCH publishers.
8. Prescott and Dunn, Industrial Microbiology. 4 th ed, 1982. AVI Pub Co.
9. Sivasankar B., Bioseparations: Principles and techniques. 2005. Prentice hall of India Ltd. Delhi.
10. Collin Ratlege, Basic Biotechnology. 2006. Cambridge university press.

## **WEB REFERENCES**

1. <https://www.ncbi.nlm.nih.gov/books/NBK234683/> (Wine Fermentation)
2. <https://www.ncbi.nlm.nih.gov/books/NBK236005/> (Downstream processing)

3. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4027325/> (Isolation and Screening)
4. <https://www.youtube.com/watch?v=3pL2X-8-eVk> (Fractional Distillation)
5. <https://www.sciencedirect.com/science/article/pii/S2095809917304241> (Photobioreactors)

### **BIO-VI.E-13: BIOETHICS AND BIOSAFETY**

COURSE TITLE: BIOETHICS AND BIOSAFETY (THEORY)

COURSE CODE: BIO-VI.E-13

MARKS: 75

CREDITS: 3

TOTAL HOURS: 45

#### **Course Objective**

This course aims at introducing the importance of the basic concepts of bioethics and biosafety and their relationship with several fields such as ecology, agriculture, medicine, chemistry and advances brought about in the field of biology and medicine. The course deals with answers to ethical questions that arise in the relationships among life sciences and their importance in the field of biotechnology.

#### **Course Outcomes**

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

CO1: Understand the importance of general safety measures in laboratories and biosafety guidelines

CO2: Justify the design of confinement facilities at different Biosafety levels,

CO3: Demonstrate good laboratory practices

CO4: Discuss the relevance of intellectual property rights to biotechnological innovations,

CO5: Describe the standard operating procedures for disposal of various types of wastes from the Biotechnology laboratory

### **BIO-VI.E-13: BIOETHICS AND BIOSAFETY (THEORY)**

#### **Module I (15 hrs)**

##### **Introduction to Bio-safety - 6 hrs**

Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels: Physical containment, Biological containment, Biosafety Levels of Specific Microorganisms; Recommended Biosafety levels for infectious agents and infected animals

##### **Safety in Laboratories - 4 hrs**

General safety measures, Hazards: Physical, Biological and Chemical, Spillage and waste disposal

##### **International and Indian biosafety guidelines - 5 hrs**

Biosafety guidelines in India; International biosafety guidelines: OECD, FAO, WHO, CAC and other organisations

#### **Module II (15 hrs)**

##### **Introduction to bioethics - 5 hrs**

Introduction to bioethics; social and ethical issues in biotechnology: issues related to test tube babies; bioethics in plant genetic engineering; bioethics in animal genetic engineering

##### **Introduction to IPR - 10 hrs**

Introduction to intellectual property; protection of intellectual property; property rights: trade secret, patent, copyright, plant variety protection; plant breeders' right: history, PPVFR, UPOV, requirements for PBR, need and benefit for PBR, breeder's exemption, farmer's privilege, farmer's

right; world intellectual property organization (WIPO), GATT & TRIPs ; patent status – international Scenario; patenting of biological materials; significance of patents in India

### **Module III (15 hrs)**

#### **Case studies - 3 hrs**

Patenting Basmati rice; Revocation of patents-turmeric and neem

#### **Protection of biotechnological inventions - 6 hrs**

Patenting of genes and DNA sequences; gene patents and genetic resources; farmers rights; plant breeder's rights; patenting of life forms; broad patents in biotechnology

#### **Regulatory affairs - 3 hrs**

Good laboratory practices; good manufacturing practices

#### **Biosafety of GMOs and GEMs - 3 hrs**

Planned introduction and field trials of: GMOs and GEMs

### **BIO-VI.E-13: BIOETHICS AND BIOSAFETY (PRACTICAL)**

COURSE TITLE: BIOETHICS AND BIOSAFETY (PRACTICAL)

COURSE CODE: BIO-VI.E-13

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

1. General safety measures and study of safety notices
2. Study of preventive measures and first aid during laboratory hazards
3. Case study on handling and disposal of radioactive waste
4. Case study on handling and disposal of medical/microbial waste
5. Study of Good Laboratory Practices
6. Study of Good Manufacturing Practices
7. Study of components and design of a Biosafety laboratory
8. A case study on clinical trials in India with emphasis to ethical issues
9. Planning of establishment of a hypothetical biotechnology industry in India
10. Study of steps of a patenting process

### **REFERENCES**

1. Das H.K. (2008). Textbook of Biotechnology, 3rd edition, Wiley India Pvt. Limited, New Delhi.
2. Dubey R.C. (1993). A Textbook of Biotechnology, S.Chand and Company, New Delhi.
3. Krishna V.S. (2007). Bioethics & Biosafety in Biotechnology, New Age Publishers, Bangalore.
4. Plummer D.T. (1988). An Introduction to Practical Biochemistry, 3 rd Edition, Tata McGraw, New York.
5. Singh B.D. (2003). Biotechnology - Expanding Horizons, 1 st edition, Kalyani Publishers, Ludhiana.
6. Thomas J.A. & Fush R.L. (2002). Biotechnology & Safety Assessment, 3 rd Edition, Academic press.

### **WEB REFERENCES**

1. [http://www.iitb.ac.in/safety/sites/default/files/BIO%20SAFETY%20IITB\\_1.pdf](http://www.iitb.ac.in/safety/sites/default/files/BIO%20SAFETY%20IITB_1.pdf) (Introduction to Bio-safety)

2. <https://www.ncbi.nlm.nih.gov/books/NBK218625/> (Introduction to Bio-safety)
3. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3217699/> (Introduction to IPR)
4. <https://www.wipo.int/export/sites/www/about-ip/en/iprm/pdf/ch1.pdf> (Introduction to IPR)
5. [http://www.fao.org/fileadmin/user\\_upload/gmfp/docs/Biosafety%20Brochure.pdf](http://www.fao.org/fileadmin/user_upload/gmfp/docs/Biosafety%20Brochure.pdf) (Biosafety of GMOs)
6. <https://www.hindawi.com/journals/isrn/2011/369573/> (Biosafety of GMOs)

## **BIO-VI.E-14 ADVANCED CELL BIOLOGY**

COURSE TITLE: ADVANCED CELL BIOLOGY (THEORY)

COURSE CODE: BIO-VI.E-14

MARKS: 75

CREDITS: 3

TOTAL HOURS: 45

PRE-REQUISITES: Completion of BIO-I.C-2- Cell Biology

### **Course Objective**

The course will give a detailed description of how eukaryotic cells receive, transmit and respond to environmental signals, cellular regulation of cell cycle progression and cell death. The principal and working of the essential tools used in cell biology will also be covered.

### **Course Outcomes**

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

CO1: Understand the theory behind the working of various techniques in cell biology.

CO2: Explain the processes of membrane transport and signal transduction.

CO3: Describe the regulation of the cell cycle events.

CO4: Isolate and visualize the subcellular organelles.

CO5: Prepare slides and identify various stages of Mitosis and Meiosis.

## **BIO-VI.E-14 ADVANCED CELL BIOLOGY (THEORY)**

### **Module I (15 hrs)**

#### **Techniques in cell biology - 10 hrs**

Review of 2D microscopy; confocal microscopy; transmission electron microscopy; scanning electron and atomic force microscopy; the use of radioisotopes; differential centrifugation; purification of proteins – precipitation; ion-exchange chromatography; gel filtration chromatography; affinity chromatography; polyacrylamide gel electrophoresis; two-dimensional gel electrophoresis; purification of nucleic acids-agarose, gel electrophoresis; ultracentrifugation, blotting techniques

#### **Membrane potentials and nerve impulses - 5 hrs**

The resting potential; the action potential; propagation of action potentials; neurotransmission

### **Module II (15 hrs)**

#### **Cell cycle and programmed cell death - 10 hrs**

Overview of the cell cycle; regulation of cell cycle; events of mitotic phase; cytokinesis; events of meiosis; regulation of cell division; apoptosis (extrinsic and intrinsic pathway)

#### **Membrane transport - 5 hrs**

Review of structure and composition of cell membrane; transport across the nuclear envelope - simple diffusion and facilitated diffusion; passive transport - glucose transporter, anion transporter;

primary active transporters - P type ATPases, V type ATPases, F type ATPases; secondary active transporters –Na<sup>+</sup>-glucose symporter; ion channels - voltage-gated ion channels (Na<sup>+</sup>/K<sup>+</sup> voltage-gated channel)

### **Module III (15 hrs)**

#### **Signal transduction - 11 hrs**

The basic elements of cell signalling systems-autocrine, paracrine and endocrine types; an overview of the major signalling pathways; mechanism and signal transduction of G protein-coupled receptors (GPCRs); Receptor protein-tyrosine kinases (RTKs); Ligand-gated channels; steroid hormone receptors; second messengers- cyclic AMP, phosphatidylinositol derived second messengers; role of calcium and NO as intracellular messengers

#### **Cancer biology - 4 hrs**

Development and causes of cancer; genetic basis of cancer; oncogenes; tumour viruses

### **BIO-VI.E-14 ADVANCED CELL BIOLOGY (PRACTICAL)**

COURSE TITLE: ADVANCED CELL BIOLOGY (PRACTICAL)

COURSE CODE: BIO-VI.E-14

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

1. Identification of different stages of mitosis (in garlic root tip) `
2. Identification of different stages of meiosis (flower buds/ grasshopper testes)
3. Study of cell viability by trypan blue
4. Identification and study of cancerous cells using permanent slides/ photomicrographs
5. Study of plant, animal and human tumour viruses using photomicrographs
6. Differential centrifugation for separation of cellular components
7. Preparation of sucrose density gradient and separation of subcellular organelles
8. Visualization of nuclear fraction by acetocarmine stain and mitochondria by Janus green stain
9. Study of electron micrographs of subcellular organelles
10. Separation of photosynthetic pigments by TLC

### **REFERENCES**

1. Karp, G. & Harris, D. (2008) Cell and Molecular Biology – Concepts and Experiments, John Wiley & Sons Inc, New York.
2. Krebs, J.E., Goldstein, E.S. & Kilpatrick, S.T. (2014). Lewin's Genes XI, Jones and Bartlett India Pvt. Ltd.
3. Nelson, D. L. & Cox, M.M. (2000). Leininger's Principles of Biochemistry (3<sup>rd</sup> Edition), Worth Publishers, New York, USA.
4. Roberti's, E.D.P. & Roberti's, E.M.F. (1998). Cell Biology and Molecular Biology, 8<sup>th</sup> edition, Sauder College.
5. Watson, J.D., Hopkins, N.H. et al. (2008). Molecular Biology of the Gene, Garland Publishing (Taylor & Francis Group), New York & London.
6. Verma, P.S. & Agarwal, V.K. (2013). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, S. Chand & Company Pvt. Ltd.

7. Verma, A.S., Das, S. & Singh, A. (2014). Laboratory Manual for Biotechnology, 1 st Edition, S. Chand & Company Pvt. Ltd.

## **WEB REFERENCES**

1. <https://www.khanacademy.org/science/biology/cell-signaling/mechanisms-of-cell-signaling/a/signal-perception> (Ligands and Receptors)
2. <https://www.khanacademy.org/test-prep/mcat/cells/transport-across-a-cell-membrane/a/passive-transport-and-active-transport-across-a-cell-membrane-article> (Active, Passive transport)
3. <https://www.ncbi.nlm.nih.gov/books/NBK12959/> (Genetic Basis of Cancer)
4. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4990352/> (Cell Cycle Checkpoints)
5. <https://www.ncbi.nlm.nih.gov/books/NBK21466/> (Cell cycle Control)
6. <https://www.khanacademy.org/science/biology/biotech-dna-technology/dna-sequencing-pcr-electrophoresis/a/gel-electrophoresis> (Gel Electrophoresis)

## **BIO-VI.E-15: FOOD BIOTECHNOLOGY**

COURSE TITLE: FOOD BIOTECHNOLOGY (THEORY)

COURSE CODE: BIO-VI.E-15

MARKS: 75

CREDITS: 3

TOTAL HOURS: 45

### **Course Objective**

This course adds information about the role of microorganisms in many food industries both in production and spoilage processes and to understand the importance of the role of microorganisms in food industries in both beneficial and harmful ways.

### **Course Outcomes**

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

CO1: Understand the important spoilage microorganisms in foods and the factors influencing their growth

CO2: Demonstrate the principles of various food preservation techniques and the importance of food quality assurance

CO3: Appreciate the importance of microorganisms as food and fermented food

CO4: Assess the quality of the milk through various tests

CO5: Debate on the Pros and cons of GM foods

## **BIO-VI.E-15: FOOD BIOTECHNOLOGY (THEORY)**

### **Module I (15 hrs)**

#### **History and development of food microbiology - 2 hrs**

History of microorganisms in food; role and significance of microorganisms in foods

#### **Factors influencing microbial growth in food - 4 hrs**

Intrinsic and extrinsic factors responsible for food spoilage

#### **Microorganisms involved in food spoilage - 2 hrs**

Microorganisms involved in food spoilage: fruits vegetables, meat, eggs, bread

#### **Food borne diseases - 4 hrs**

Food poisoning: (bacterial toxin botulism and Staphylococcal toxin); fungal toxins: aflatoxin; food borne infections: gastroenteritis and Salmonellosis

## **Microorganisms as source of food - 3 hrs**

Nutritive value and use of: Mushrooms Ex: Spirulina

## **Module II (15 hrs)**

### **Milk Microbiology - 6 hrs**

Sources of contamination; different microorganisms implicated in spoilage; milk borne diseases: listeriosis and scarlet fever; grading of milk by dye reduction test – MBRT and resazurin

### **Detection of food spoilage - 6 hrs**

Methods of detection of food spoilage in any 1 type of food (example milk); traditional approaches in detection of spoilage (SCP, breeds smear, identification of specific; organisms by using selective and differential media); new approaches (examples gene probes, bioluminescence)

### **Food quality assurance - 3 hrs**

Food safety: HACCP system to food protection

## **Module III (15 hrs)**

### **Food preservation - 8 hrs**

Preservation by drying: solar drying, mechanical drying, salting, smoking); preservation at high temperature: concept of TDP and TDT ; pasteurization (LTHT, HTST, UHT processes); efficiency of pasteurization – phosphatase test, canning, hurdle technology ; preservation at low temperature: freezing preservation by use of additives: acids, salts, sugars, antibiotics, ethylene oxide, antioxidants; preservation by radiation: UV, ionizing radiations, gamma and cathode rays, microwave processing; other methods: hydrostatic pressure cooking, modified atmosphere

### **Fermentation technology - 3 hrs**

Fermented Food: process, microbiology involved and changes during fermentation of fermented food: sauerkraut; milk products: yogurt

### **GM foods - 4 hrs**

Pros and cons of GM foods Eg: Golden rice, FlavrSavr tomato and Bt Brinjal

## **BIO-VI.E-15: FOOD BIOTECHNOLOGY (PRACTICAL)**

COURSE TITLE: FOOD BIOTECHNOLOGY (PRACTICAL)

COURSE CODE: BIO-VI.E-15

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

1. Plating of spoiled food on selective media
2. MIC of common food preservatives – (sugar/ salt)
3. MIC of chemical food preservatives – (sodium benzoate/ potassium meta-bisulphite) Milk Microbiology
4. Standard plate count
5. Grading of quality of milk using dye reduction test (MBDRT / Resazurin)
6. Pasteurisation of milk
7. Determination of efficiency of pasteurisation by phosphatase test
8. Determination of TDP and TDT



## REFERENCES

1. Das H.K. (2007). Textbook of Biotechnology, 3<sup>rd</sup> Edition, Wiley India (P) Ltd, New Delhi.
2. Frazier W.C & Westhoff D.C. (2015). Food Microbiology. 5<sup>th</sup> edition. McGraw Hill Education
3. (India) Private Limited: New Delhi
4. Jay J.M., Loessner, M.J. & Golden D. A. (2005). Modern Food Microbiology, 7<sup>th</sup> edition. United States: Springer science business media
5. Jogdand S. N. (2004). Medical Biotechnology, Himalaya publishing house Pvt. Ltd, India.
6. Purohit S.S. (2004). Biotechnology: Fundamentals and applications Agrobios, Jodhpur.
7. Ray B. (2004). Fundamental food microbiology, 3<sup>rd</sup> edition. CRC press: Washington D.C
8. Satyanarayan U. (2009). Biotechnology, Books and Allied Pvt Ltd, Calcutta.
9. Singh B.D. (2004). Biotechnology: Expanding horizons, Kalyani Publishers, New Delhi.
10. Tiwari R.P., Hoondal G.S. & Tewari R. (2009). Laboratory Techniques in Microbiology and Biotechnology, Abhishek Publications Chandigarh (India).

## WEB REFERENCES

1. <https://www.britannica.com/topic/food-preservation> (Food Preservation)
2. <https://www.sciencedirect.com/topics/food-science/food-borne-disease> (Food borne diseases)
3. <https://dairyprocessinghandbook.tetrapak.com/chapter/microbiology> (Milk Microbiology)

## BIO-VI.E-16: ANIMAL CELL CULTURE

COURSE TITLE: ANIMAL CELL CULTURE (THEORY)

COURSE CODE: BIO-VI. E-16

MARKS: 75

CREDITS: 3

TOTAL HOURS: 45

### Course Objective

This course is designed to introduce the students to the basic concepts of Animal Cell Culture. The paper covers topics that explain animal cell culturing and methods involved in basic culturing of animal cells with a few applications to life sciences.

### Course Outcomes

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

CO1: Understand the basic concepts of animal cell culture.

CO2: Comprehend the various requirements and techniques for animal cell culture and importance of the same.

CO3: Understand the importance of primary and established cell lines for biotechnological applications.

CO4: Appreciate the various methods of characterization and growth assessment techniques in culturing animal cells.

CO5: Understand the applications of animal cells in the development of disease diagnostics and therapeutics.

## BIO-VI.E-16: ANIMAL CELL CULTURE (THEORY)

### Module I (15 hrs)

#### Introduction to animal cell culture - 2 hrs

Animal Tissue and Cell Culture (Definition and Concepts in brief), History and Scope of Animal Tissue Culture

**Requirements for animal cell culture - 4 hrs**

Basic layout of an animal cell culture laboratory (washing room, media preparation & sterilization room, inoculation and aseptic culture room); equipment; culture vessels for tissue culture

**Basics of an animal cell - 3 hrs**

Structure and organization of animal cell; an overview of developmental biology (importance in understanding differentiation of cells in culture)

**Media in animal cell culturing - 6 hrs**

Physicochemical properties of culture media (pH, CO<sub>2</sub>, O<sub>2</sub> and temperature); growth media (types, advantages and disadvantages of each type); natural and artificial media; natural media – clots, biological fluid, tissue extracts, complex natural media; artificial media – serum containing, serum-free media, chemically defined and protein-free media; basal salt solutions (BSS) – constituents (vitamins, amino acids, trace elements, inorganic ions); importance; uses and examples; serum as a complex supplement; growth factors in promoting proliferation of cells – uses and examples (EGF, FGF, PDGF)

**Module II (15 hrs)****Basic techniques in animal cell culture - 6 hrs**

Techniques in mammalian cell culture – source of cells; dissection/isolation of cells; mechanical and enzymatic disaggregation; types of cell cultures (organ culture, whole embryo culture, histotypic cultures, explants cultures)

**Cell line cultures - 6 hrs**

Primary and established cell line cultures; establishment of continuous cell lines – spontaneous transformation; chemical transformation; viral transformation; non-chemical methods; characteristics & maintenance of established / continuous cell lines; characteristics of normal and transformed cells (properties of transformed cells)

**Normal cell growth, phases of growth in culture and synchronization of cells - 3 hrs**

Eukaryotic cell cycle and basics of cell synchronization; apoptosis in cultured cells – Reasons for cell suicide; phases of cell growth (lag, log, stationary, decline); population doubling level; morphology

**Module III (15 hrs)****Characterization and growth measurement of cultured cells - 6 hrs**

Characterization – genetic and enzymatic methods (cytogenetics, karyotyping, Isoenzymes and immunological tests); growth measurement – direct method (particle counter, dye exclusion test, cytotoxicity assay); growth measurement – indirect method (MTT assay)

**Cell separation methods - 3 hrs**

Physical method of cell separation – separation based on cell size; cell density; cell surface charge; cell affinity; separation by flow cytometry

**Applications of animal cell culture - 6 hrs**

Stem cell culture (applications in Animal Cell Culture); artificial skin; artificial cartilage; special secondary metabolites / products (insulin, growth hormone, interferon, t-plasminogen); other valuable products obtained using animal cell cultures (emphasis on monoclonal and polyclonal antibodies)

**BIO-VI.E-16: ANIMAL CELL CULTURE (PRACTICAL)**

COURSE TITLE: ANIMAL CELL CULTURE (PRACTICAL)

COURSE CODE: BIO-VI.E-16

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

1. Washing of glassware and culture wares, preparation of animal cell culture media, sterilization
2. Introduction to use of instruments and sterile techniques in animal cell culture
3. Preparation of Basal Salt Solutions (DPBS) and filter sterilization
4. Preparation of culture media for animal cell culture (DMEM / RPMI 1640) using BSS.
5. Preparation of serum from goat blood & filter sterilization for animal cell culture
6. Culturing lymphocytes from blood cells using RPMI 1640
7. Dissection of chick embryo for culturing fibroblast cells
8. Estimation of cell viability using MTT & calculations of seeding density for animal cell cultures
9. Establishing a monolayer culture using warm trypsinization method
10. Establishing a monolayer culture using cold trypsinization method
11. Subculture of monolayer culture

**REFERENCES**

1. Das, H.K. (2005). Textbook of Biotechnology, Wiley India Pvt. Ltd.
2. Freshney, I.R. (2005). Culture of animal cell –A Manual of Basic Techniques, 5<sup>th</sup> Edition, Wiley-Liss Publications.
3. Gangal, S. (2010). Principles and Practice of Animal Tissue Culture, 2nd edition, Universities Press.
4. Shivangi, M. (2006). Animal Cell and Tissue Culture, Agrobios, India.
5. Singh, B.D (2013). Biotechnology, Expanding horizons, Kalyani Publishers, New Delhi.

**WEB REFERENCES**

1. <https://onlinelibrary.wiley.com/doi/full/10.1002/rmb2.12024> (Requirements and media for animal cell culture)
2. <https://books.google.com/books?hl=en&lr=&id=GyfLBAAQBAJ&oi=fnd&pg=PP1&dq=requirements+of+animal+cell+culture&ots=G6-CoDHnJW&sig=Zyukoy1RdMEMHDDwriHhMLATOIY> (Techniques in animal cell culture)
3. <https://link.springer.com/book/10.1007%2F978-3-319-10320-4> (Techniques in animal cell culture)
4. [https://link.springer.com/protocol/10.1007/978-1-62703-733-4\\_7](https://link.springer.com/protocol/10.1007/978-1-62703-733-4_7) (Media for animal cell culture)

**BIO-VI.E-16: ANIMAL CELL CULTURE (PRACTICAL)**

COURSE TITLE: ANIMAL CELL CULTURE (PRACTICAL)

COURSE CODE: BIO-VI.E-16

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

1. Washing of glassware and culture wares, preparation of animal cell culture media, sterilization
2. Introduction to use of instruments and sterile techniques in animal cell culture
3. Preparation of Basal Salt Solutions (DPBS) and filter sterilization
4. Preparation of culture media for animal cell culture (DMEM / RPMI 1640) using BSS.
5. Preparation of serum from goat blood & filter sterilization for animal cell culture
6. Culturing lymphocytes from blood cells using RPMI 1640
7. Dissection of chick embryo for culturing fibroblast cells
8. Estimation of cell viability using MTT & calculations of seeding density for animal cell cultures
9. Establishing a monolayer culture using warm trypsinization method
10. Establishing a monolayer culture using cold trypsinization method
11. Subculture of monolayer culture

## REFERENCES

1. Das, H.K. (2005). Textbook of Biotechnology, Wiley India Pvt. Ltd.
2. Freshney, I.R. (2005). Culture of animal cell –A Manual of Basic Techniques, 5th Edition, Wiley- Liss Publications.
3. Gangal, S. (2010). Principles and Practice of Animal Tissue Culture, 2nd edition, Universities Press.
4. Shivangi, M. (2006). Animal Cell and Tissue Culture, Agrobios, India.
5. Singh, B.D (2013). Biotechnology, Expanding horizons, Kalyani Publishers, New Delhi.

## WEB REFERENCES

1. <https://onlinelibrary.wiley.com/doi/full/10.1002/rmb2.12024> (Requirements and media for animal cell culture)
2. <https://books.google.com/books?hl=en&lr=&id=GyfLBAAQBAJ&oi=fnd&pg=PP1&dq=requirements+of+animal+cell+culture&ots=G6-CoDHnJW&sig=Zyukoy1RdMEMHDDwriHhMLATOIY> (Techniques in animal cell culture)
3. <https://link.springer.com/book/10.1007%2F978-3-319-10320-4> (Techniques in animal cell culture)
4. [https://link.springer.com/protocol/10.1007/978-1-62703-733-4\\_7](https://link.springer.com/protocol/10.1007/978-1-62703-733-4_7) (Media for animal cell Culture)
5. [https://books.google.co.in/books?hl=en&lr=&id=GyfLBAAQBAJ&oi=fnd&pg=PP1&dq=requirements+of+animal+cell+culture&ots=G6-CoDHnJW&sig=Zyukoy1RdMEMHDDwriHhMLATOIY&redir\\_esc=y](https://books.google.co.in/books?hl=en&lr=&id=GyfLBAAQBAJ&oi=fnd&pg=PP1&dq=requirements+of+animal+cell+culture&ots=G6-CoDHnJW&sig=Zyukoy1RdMEMHDDwriHhMLATOIY&redir_esc=y) (Methods in animal cell culture)
6. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3931621/> (Characterisation of animal cells)
7. <https://link.springer.com/article/10.1007/s11051-015-2958-9> (Growth assessment of animal cells)
8. [https://link.springer.com/protocol/10.1007/978-1-4939-2074-7\\_26](https://link.springer.com/protocol/10.1007/978-1-4939-2074-7_26) (Viability assays for animal cell culture)
9. <https://www.hindawi.com/journals/bmri/2015/285869/> (Applications of animal cell culture)
10. <https://www.liebertpub.com/doi/abs/10.1089/ten.TEB.2014.0086> (Application of animal cell culture in tissue engineering)
11. <https://www.tandfonline.com/doi/full/10.3109/21691401.2016.1146731> (General applications of animal cell culture)

## 14. Learning Outcome Matrix

MATRIX -1 (Entire Programme)									
MAPPING COURSES/ACTIVITIES TO PROGRAMME LEARNING OUTCOME									
PROGRAMME: B.Sc. in Biotechnology									
<div>PLOS</div> <div>Course / Activity</div>		PLO-1: Use of Techno logy, Proble m Analysi s and Solutio ns	PLO-2 Envirom ent Sustaina bility & Ethics	PLO -3: Individual and Team work, Communi cationa & Life Skills	PLO-4: Researc h Aptitud e & Social respons ibility	PLO-5: Critical thinkin g, Analysi s and Problem Solving	PLO-6 Underst anding the need for sustain able solutio ns	PLO-7: Develop ment of practica l skills	PLO-8: Developi ng an inclinati on towards research)
Courses Component A	BIO-I.C-1: BIOMOLECULES	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	BIO-I.C-2: CELL BIOLOGY	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	BIO-II.C-3: FUNDAMENTAL GENETICS	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	BIO-II.C-4: BASIC MICROBIOLOGY	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	BIO-III.C-5: MOLECULAR BIOLOGY	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	BIO-III.E-1: BASICS OF PLANT AND ANIMAL SCIENCES	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	BIO-III.E-2: METABOLISM OF BIOMOLECULES	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	BIO-III.E-3: BIOSTATISTICS	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	BIO-III.E-4: ENZYMOLGY	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	BIO-IV.C-6: IMMUNOLOGY	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	BIO-IV.E-5: PLANT & ANIMAL PHYSIOLOGY	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	BIO-IV.E-6: TOOLS AND TECHNIQUES	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	BIO-IV.E-7: EVOLUTION AND ANTHROPOLOGY	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	BIO-IV.E-8: MOLECULAR GENETICS	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	BIO-V.C-7: CONCEPTS IN GENETIC ENGINEERING	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	BIO-V.E-9 MOLECULAR MEDICINE	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
BIO-V.E-10: ENVIRONMENTAL BIOTECHNOLOGY	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
BIO-V.E-11: PLANT BIOTECHNOLOGY	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
BIO-V.E-12: BIOINFORMATICS	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	

[illegible]**F.Y.B.Sc. Biotechnology**

<b>MATRIX -2</b> (BIO-I.C-1: BIOMOLECULES)								
<b>MAPPING OF PROGRAMME LEARNING OUTCOME TO COURSE LEARNING OUTCOMES</b>								
<b>Programme: Biotechnology</b>								
<b>Type of Course:</b> (Core)								
<b>Course Code:</b> BIO-I.C-1								
<b>Course Title:</b> BIOMOLECULES								
<div> PLOs CLOs </div>	<b>PLO-1:</b> Use of Technology, Problem Analysis and Solutions	<b>PLO-2:</b> Environment Sustainability & Ethics	<b>PLO-3:</b> Individual and Team work, Communication & Life Skills	<b>PLO-4:</b> Research Aptitude & Social responsibility	<b>PLO-5:</b> Critical thinking, Analysis and Problem Solving	<b>PLO-6:</b> Understanding the need for sustainable solutions	<b>PLO-7:</b> Development of practical skills	<b>PLO-8:</b> Developing an inclination towards research)
<b>1</b>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<b>2</b>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<b>3</b>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<b>4</b>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<b>5</b>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

### MAPPING OF PROGRAMME LEARNING OUTCOME TO COURSE LEARNING OUTCOMES

**Course Title:** *CELL BIOLOGY*

<b>PLOs</b> <b>CLOs</b>	<b>PLO-1:</b> Use of Technolog y, Problem Analysis and Solutions	<b>PLO-2:</b> Environm ent Sustainab ility & Ethics	<b>PLO-3:</b> Individ ual and Team work, Communi cation & Life Skills	<b>PLO-4:</b> Research Aptitude & Social responsibilit y	<b>PLO-5:</b> <i>Critical thinking, Analysis and Problem Solving</i>	<b>PLO-6</b> Understan ding the need for sustainabl e solutions	<b>PLO-7:</b> Developme nt of practical skills	<b>PLO-8:</b> Developing an inclination towards research)
<b>1</b>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<b>2</b>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<b>3</b>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<b>4</b>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<b>5</b>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

### MAPPING OF PROGRAMME LEARNING OUTCOME TO COURSE LEARNING OUTCOMES

**Course Title:** *FUNDAMENTAL GENETICS*

<div> <div>PLOs</div> <div>CLOs</div> </div>	PLO-1: Use of Technology, Problem Analysis and Solutions	PLO-2: Environm ent Sustainab ility & Ethics	PLO -3: Individ ual and Team work, Communi cation & Life Skills	PLO-4: Research Aptitude & Social responsibilit y	PLO-5: <i>Critical thinking, Analysis and Problem Solving</i>	PLO-6 Understan ding the need for sustainabl e solutions	PLO-7: Developme nt of practical skills	PLO-8: Developing an inclination towards research)
1	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
3	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
4	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
5	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

### MAPPING OF PROGRAMME LEARNING OUTCOME TO COURSE LEARNING OUTCOMES

**Course Title:** *BASIC MICROBIOLOGY*

<div>PLOs</div> <div>CLOs</div>	PLO-1: Use of Technology, Problem Analysis and Solutions	PLO-2: Environment Sustainability & Ethics	PLO-3: Individual and Team work, Communication & Life Skills	PLO-4: Research Aptitude & Social responsibility	PLO-5: Critical thinking, Analysis and Problem Solving	PLO-6: Understanding the need for sustainable solutions	PLO-7: Development of practical skills	PLO-8: Developing an inclination towards research)
1	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
3	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
4	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
5	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

**MATRIX -2** (BIO-III.C-5: MOLECULAR BIOLOGY)

### MAPPING OF PROGRAMME LEARNING OUTCOME TO COURSE LEARNING OUTCOMES

**Course Title:** *MOLECULAR BIOLOGY*

<div>PLOs</div> <div>CLOs</div>	PLO-1: Use of Technolog y, Problem Analysis and Solutions	PLO-2: Environm ent Sustainab ility & Ethics	PLO -3: Individ ual and Team work, Communi cation & Life Skills	PLO-4: Research Aptitude & Social responsibilit y	PLO-5: <i>Critical thinking, Analysis and Problem Solving</i>	PLO-6 Understan ding the need for sustainabl e solutions	PLO-7: Developme nt of practical skills	PLO-8: Developing an inclination towards research)
1	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
3	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
4	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
5	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>



### MAPPING OF PROGRAMME LEARNING OUTCOME TO COURSE LEARNING OUTCOMES

**Course Title:** *BASICS OF PLANT AND ANIMAL SCIENCES*

<div> <div>PLOs</div> <div>CLOs</div> </div>	PLO-1: Use of Technology, Problem Analysis and Solutions	PLO-2: Environment Sustainability & Ethics	PLO-3: Individual and Team work, Communication & Life Skills	PLO-4: Research Aptitude & Social responsibility	PLO-5: Critical thinking, Analysis and Problem Solving	PLO-6: Understanding the need for sustainable solutions	PLO-7: Development of practical skills	PLO-8: Developing an inclination towards research)
1	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
2	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
3	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
4	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
5	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

## MAPPING OF PROGRAMME LEARNING OUTCOME TO COURSE LEARNING OUTCOMES

**Course Title:** *METABOLISM OF BIOMOLECULES*

<div>PLOs</div> <div>CLOs</div>	PLO-1: Use of Technology, Problem Analysis and Solutions	PLO-2: Environment Sustainability & Ethics	PLO-3: Individual and Team work, Communication & Life Skills	PLO-4: Research Aptitude & Social responsibility	PLO-5: Critical thinking, Analysis and Problem Solving	PLO-6: Understanding the need for sustainable solutions	PLO-7: Development of practical skills	PLO-8: Developing an inclination towards research)
1	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
3	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
4	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
5	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

### MAPPING OF PROGRAMME LEARNING OUTCOME TO COURSE LEARNING OUTCOMES

**Course Title:** *BIOSTATISTICS*

[illegible]

## MAPPING OF PROGRAMME LEARNING OUTCOME TO COURSE LEARNING OUTCOMES

**Course Title:** *ENZYMOLLOGY*

<div>PLOs</div> <div>CLOs</div>	PLO-1: Use of Technology, Problem Analysis and Solutions	PLO-2: Environm ent Sustainab ility & Ethics	PLO-3: Individ ual and Team work, Communi cation & Life Skills	PLO-4: Research Aptitude & Social responsibilit y	PLO-5: <i>Critical thinking, Analysis and Problem Solving</i>	PLO-6 Understan ding the need for sustainabl e solutions	PLO-7: Developme nt of practical skills	PLO-8: Developing an inclination towards research)
1	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
3	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
4	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
5	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

### MAPPING OF PROGRAMME LEARNING OUTCOME TO COURSE LEARNING OUTCOMES

**Course Title:** *IMMUNOLOGY*

<div> <div>PLOs</div> <div>CLOs</div> </div>	PLO-1: Use of Technology, Problem Analysis and Solutions	PLO-2: Environment Sustainability & Ethics	PLO-3: Individual and Team work, Communication & Life Skills	PLO-4: Research Aptitude & Social responsibility	PLO-5: <i>Critical thinking, Analysis and Problem Solving</i>	PLO-6: Understanding the need for sustainable solutions	PLO-7: Development of practical skills	PLO-8: Developing an inclination towards research)
1	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
3	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
4	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
5	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

## MAPPING OF PROGRAMME LEARNING OUTCOME TO COURSE LEARNING OUTCOMES

**Course Title:** *PLANT AND ANIMAL PHYSIOLOGY*

<div> <div>PLOs</div> <div>CLOs</div> </div>	PLO-1: Use of Technology, Problem Analysis and Solutions	PLO-2: Environment Sustainability & Ethics	PLO-3: Individual and Team work, Communication & Life Skills	PLO-4: Research Aptitude & Social responsibility	PLO-5: <i>Critical thinking, Analysis and Problem Solving</i>	PLO-6 Understanding the need for sustainable solutions	PLO-7: Development of practical skills	PLO-8: Developing an inclination towards research)
1	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
3	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
4	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
5	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

### MAPPING OF PROGRAMME LEARNING OUTCOME TO COURSE LEARNING OUTCOMES

**Course Title:** *TOOLS AND TECHNIQUES IN BIOTECHNOLOGY*

<div> <div>PLOs</div> <div>CLOs</div> </div>	PLO-1: Use of Technology, Problem Analysis and Solutions	PLO-2: Environm ent Sustainab ility & Ethics	PLO -3: Individ ual and Team work, Communi cation & Life Skills	PLO-4: Research Aptitude & Social responsibilit y	PLO-5: <i>Critical thinking, Analysis and Problem Solving</i>	PLO-6 Understan ding the need for sustainabl e solutions	PLO-7: Developme nt of practical skills	PLO-8: Developing an inclination towards research)
1	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
3	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
4	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
5	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

## MAPPING OF PROGRAMME LEARNING OUTCOME TO COURSE LEARNING OUTCOMES

**Course Title:** *EVOLUTION AND ANTHROPOLOGY*

<div> <div>PLOs</div> <div>CLOs</div> </div>	PLO-1: Use of Technology, Problem Analysis and Solutions	PLO-2: Environment Sustainability & Ethics	PLO-3: Individual and Team work, Communication & Life Skills	PLO-4: Research Aptitude & Social responsibility	PLO-5: <i>Critical thinking, Analysis and Problem Solving</i>	PLO-6 Understanding the need for sustainable solutions	PLO-7: Development of practical skills	PLO-8: Developing an inclination towards research)
1	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
3	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
4	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
5	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

### MAPPING OF PROGRAMME LEARNING OUTCOME TO COURSE LEARNING OUTCOMES

**Course Title:** *MOLECULAR GENETICS*

<div> <div>PLOs</div> <div>CLOs</div> </div>	PLO-1: Use of Technology, Problem Analysis and Solutions	PLO-2: Environment Sustainability & Ethics	PLO -3: Individual and Team work, Communication & Life Skills	PLO-4: Research Aptitude & Social responsibility	PLO-5: <i>Critical thinking, Analysis and Problem Solving</i>	PLO-6 Understanding the need for sustainable solutions	PLO-7: Development of practical skills	PLO-8: Developing an inclination towards research)
1	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
3	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
4	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
5	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

**MATRIX -2** (BIO-V.C-7: CONCEPTS IN GENETIC ENGINEERING)

### MAPPING OF PROGRAMME LEARNING OUTCOME TO COURSE LEARNING OUTCOMES

**Course Title:** *CONCEPTS IN GENETIC ENGINEERING*

<div>PLOs</div> <div>CLOs</div>	PLO-1: Use of Technology, Problem Analysis and Solutions	PLO-2: Environment Sustainability & Ethics	PLO-3: Individual and Team work, Communication & Life Skills	PLO-4: Research Aptitude & Social responsibility	PLO-5: <i>Critical thinking, Analysis and Problem Solving</i>	PLO-6: Understanding the need for sustainable solutions	PLO-7: Development of practical skills	PLO-8: Developing an inclination towards research)
1	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
3	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
4	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
5	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

### MAPPING OF PROGRAMME LEARNING OUTCOME TO COURSE LEARNING OUTCOMES

**Course Title:** *MOLECULAR MEDICINE*

<div>PLOs</div> <div>CLOs</div>	PLO-1: Use of Technolog y, Problem Analysis and Solutions	PLO-2: Environm ent Sustainab ility & Ethics	PLO -3: Individ ual and Team work, Communi cation & Life Skills	PLO-4: Research Aptitude & Social responsibilit y	PLO-5: <i>Critical thinking, Analysis and Problem Solving</i>	PLO-6 Understan ding the need for sustainabl e solutions	PLO-7: Developme nt of practical skills	PLO-8: Developing an inclination towards research)
1	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
3	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
4	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
5	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

### MAPPING OF PROGRAMME LEARNING OUTCOME TO COURSE LEARNING OUTCOMES

**Course Title:** *ENVIRONMENTAL BIOTECHNOLOGY*

<div> <div>PLOs</div> <div>CLOs</div> </div>	PLO-1: Use of Technolog y, Problem Analysis and Solutions	PLO-2: Environm ent Sustainab ility & Ethics	PLO -3: Individ ual and Team work, Commu nicatio n & Life Skills	PLO-4: Research Aptitude & Social responsibilit y	PLO-5: <i>Critical thinking, Analysis and Problem Solving</i>	PLO-6 Understan ding the need for sustainabl e solutions	PLO-7: Developme nt of practical skills	PLO-8: Developing an inclination towards research)
1	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
3	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
4	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
5	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

### MAPPING OF PROGRAMME LEARNING OUTCOME TO COURSE LEARNING OUTCOMES

**Course Title:** *PLANT BIOTECHNOLOGY*

<div> <div>PLOs</div> <div>CLOs</div> </div>	PLO-1: Use of Technolog y, Problem Analysis and Solutions	PLO-2: Environm ent Sustainab ility & Ethics	PLO -3: Individ ual and Team work, Commu nicatio n & Life Skills	PLO-4: Research Aptitude & Social responsibilit y	PLO-5: <i>Critical thinking, Analysis and Problem Solving</i>	PLO-6 Understan ding the need for sustainabl e solutions	PLO-7: Developme nt of practical skills	PLO-8: Developing an inclination towards research)
1	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
3	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
4	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
5	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

## MAPPING OF PROGRAMME LEARNING OUTCOME TO COURSE LEARNING OUTCOMES

**Course Title:** *BIOINFORMATICS*

<div>PLOs</div> <div>CLOs</div>	PLO-1: Use of Technology, Problem Analysis and Solutions	PLO-2: Environment Sustainability & Ethics	PLO-3: Individual and Team work, Communication & Life Skills	PLO-4: Research Aptitude & Social responsibility	PLO-5: <i>Critical thinking, Analysis and Problem Solving</i>	PLO-6 Understanding the need for sustainable solutions	PLO-7: Development of practical skills	PLO-8: Developing an inclination towards research)
1	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
3	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
4	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
5	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

**MATRIX -2** (*BIO-VI.C-8: INDUSTRIAL BIOTECHNOLOGY*)  
**MAPPING OF PROGRAMME LEARNING OUTCOME TO COURSE LEARNING OUTCOMES**

**Course Title:** *INDUSTRIAL BIOTECHNOLOGY*

<div> <div>PLOs</div> <div>CLOs</div> </div>	PLO-1: Use of Technolog y, Problem Analysis and Solutions	PLO-2: Environm ent Sustainab ility & Ethics	PLO -3: Individ ual and Team work, Commu nicatio n & Life Skills	PLO-4: Research Aptitude & Social responsibilit y	PLO-5: <i>Critical thinking, Analysis and Problem Solving</i>	PLO-6 Understan ding the need for sustainabl e solutions	PLO-7: Developme nt of practical skills	PLO-8: Developing an inclination towards research)
1	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
3	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
4	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
5	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

**MATRIX -2** (*BIO-VI.E-13: BIOETHICS AND BIOSAFETY*)  
**MAPPING OF PROGRAMME LEARNING OUTCOME TO COURSE LEARNING OUTCOMES**

**Course Title:** *BIOETHICS AND BIOSAFETY*

[illegible]



## MAPPING OF PROGRAMME LEARNING OUTCOME TO COURSE LEARNING OUTCOMES

**Course Title:** *ADVANCED CELL BIOLOGY*

<div>PLOs</div> <div>CLOs</div>	PLO-1: Use of Technology, Problem Analysis and Solutions	PLO-2: Environment Sustainability & Ethics	PLO-3: Individual and Team work, Communication & Life Skills	PLO-4: Research Aptitude & Social responsibility	PLO-5: <i>Critical thinking, Analysis and Problem Solving</i>	PLO-6: Understanding the need for sustainable solutions	PLO-7: Development of practical skills	PLO-8: Developing an inclination towards research)
1	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
3	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
4	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
5	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

## MAPPING OF PROGRAMME LEARNING OUTCOME TO COURSE LEARNING OUTCOMES

**Course Title:** *FOOD BIOTECHNOLOGY*

[illegible]

**MATRIX -2** (BIO-VI.E-16: ANIMAL CELL CULTURE)

**MAPPING OF PROGRAMME LEARNING OUTCOME TO COURSE LEARNING OUTCOMES**

**Type of Course:** *(DSE)*

**Course Title:** *ANIMAL CELL CULTURE*

<div>PLOs</div> <div>CLOs</div>	PLO-1: Use of Technolog y, Problem Analysis and Solutions	PLO-2: Environm ent Sustainab ility & Ethics	PLO-3: Individ ual and Team work, Communi cation & Life Skills	PLO-4: Research Aptitude & Social responsibilit y	PLO-5: <i>Critical thinking, Analysis and Problem Solving</i>	PLO-6: Understan ding the need for sustainabl e solutions	PLO-7: Developme nt of practical skills	PLO-8: Developing an inclination towards research)
1	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
3	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
4	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
5	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

## MAPPING TEACHING METHODS/PEDAGOGIES TO CLOs AND PLOs

**Course: Biomolecules**

[illegible]

**Blooms Taxonomy: 1-Remembering, 2-Understanding, 3-Applying, 4-Analysing, 5-Evaluating, 6-Creating**

<div>MATRIX 3</div> <div>MAPPING TEACHING METHODS/PEDAGOGIES TO CLOs AND PLOs</div> <div>PROGRAMME: BSc in Biotechnology Course: Cell Biology</div>														
Blooms Taxonomy	T-L-E modes	CLO -1	CLO 2	CLO 3	CLO 4	CL O 5	PL O 1	PL O2	PL O3	PL O4	PL O5	PL O6	PL O7	PLO 8
1 - 5	Traditional Lecture Method	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
1 - 5	Interactive Lecture Method	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2 & 4	Group Discussion	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Debate	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2 & 4	Experiential Learning	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Out-door Experiments	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2, 3, 4, 5, 6	Laboratory Work	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	POGIL	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Flipped Classroom	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Field based studies	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Problem Based Learning	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Project based Learning	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<div>Blooms Taxonomy: 1-Remembering, 2-Understanding, 3-Applying, 4-Analysing, 5-Evaluating, 6-Creating</div>														

<b>MATRIX 3</b> <b>MAPPING TEACHING METHODS/PEDAGOGIES TO CLOs AND PLOs</b> <b>PROGRAMME: BSc in Biotechnology Course: Fundamental Genetics</b>														
<b>Blooms Taxonomy</b>	<b>T-L-E modes</b>	<b>CLO -1</b>	<b>CLO 2</b>	<b>CLO 3</b>	<b>CLO 4</b>	<b>CL O 5</b>	<b>PL O 1</b>	<b>PL O2</b>	<b>PL O3</b>	<b>PL O4</b>	<b>PL O5</b>	<b>PL O6</b>	<b>PL O7</b>	<b>PLO 8</b>
2	Traditional Lecture Method	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2 & 3	Interactive Lecture Method	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
3	Group Discussion	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
3 & 4	Debate	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
3	Experiential Learning	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Out-door Experiments	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1 & 2	Laboratory Work	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	POGIL	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Flipped Classroom	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Field based studies	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3 & 4	Problem Based Learning	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Project based Learning	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**Blooms Taxonomy: 1-Remembering, 2-Understanding, 3-Applying, 4-Analysing, 5-Evaluating, 6-Creating**

<p align="center"><b>MATRIX 3</b></p> <p align="center"><b>MAPPING TEACHING METHODS/PEDAGOGIES TO CLOs AND PLOs</b></p> <p align="center"><b>PROGRAMME: BSc in Biotechnology</b></p> <p align="center"><b>Course: Basic Microbiology</b></p>														
Level of Blooms Taxonomy (1-6)	T-L-E modes	CLO -1	CLO 2	CLO 3	CLO 4	CL O 5	PL O 1	PL O2	PL O3	PL O4	PL O5	PL O6	PL O7	PLO 8
1 - 5	Traditional Lecture Method	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
1 - 5	Interactive Lecture Method	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2 & 4	Group Discussion	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Debate	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2 & 4	Experiential Learning	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Out-door Experiments	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2, 3, 4, 5, 6	Laboratory Work	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
1 - 5	POGIL	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1 - 5	Flipped Classroom	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2 & 4	Field based studies	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1 - 6	Problem Based Learning	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2 & 4	Project based Learning	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**Blooms Taxonomy: 1-Remembering, 2-Understanding, 3-Applying, 4-Analysing, 5-Evaluating, 6-Creating**

<p align="center"><b>MATRIX 3</b></p> <p align="center"><b>MAPPING TEACHING METHODS/PEDAGOGIES TO CLOs AND PLOs</b></p> <p align="center"><b>PROGRAMME: BSc in Biotechnology</b></p> <p align="center"><b>Course: Molecular Biology</b></p>														
Level of Blooms Taxonomy (1-6)	T-L-E modes	CLO -1	CLO 2	CLO 3	CLO 4	CL O 5	PL O 1	PL O2	PL O3	PL O4	PL O5	PL O6	PL O7	PLO 8
2	Traditional Lecture Method	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
3	Interactive Lecture Method	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
3	Group Discussion	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
4	Debate	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Experiential Learning	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Out-door Experiments	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2 & 4	Laboratory Work	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	POGIL	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Flipped Classroom	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Field based studies	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Problem Based Learning	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Project based Learning	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

**Blooms Taxonomy: 1-Remembering, 2-Understanding, 3-Applying, 4-Analysing, 5-Evaluating, 6-Creating**

<b>MATRIX 3</b> <b>MAPPING TEACHING METHODS/PEDAGOGIES TO CLOs AND PLOs</b> <b>PROGRAMME: BSc in Biotechnology</b> <b>Course: Basics of Plant and Animal Sciences</b>														
Level of Blooms Taxonomy (1-6)	T-L-E modes	CLO -1	CLO 2	CLO 3	CLO 4	CLO 5	PL O 1	PL O2	PL O3	PL O4	PL O5	PL O6	PL O7	PLO 8
2	Traditional Lecture Method	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2 & 3	Interactive Lecture Method	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
3	Group Discussion	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
3 & 4	Debate	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
3	Experiential Learning	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Out-door Experiments	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1 & 2	Laboratory Work	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	POGIL	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Flipped Classroom	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Field based studies	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3 & 4	Problem Based Learning	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Project based Learning	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**Blooms Taxonomy: 1-Remembering, 2-Understanding, 3-Applying, 4-Analysing, 5-Evaluating, 6-Creating**

<p align="center"><b>MATRIX 3</b></p> <p align="center"><b>MAPPING TEACHING METHODS/PEDAGOGIES TO CLOs AND PLOs</b></p> <p align="center"><b>PROGRAMME: BSc in Biotechnology</b></p> <p align="center"><b>Course: Metabolism of Biomolecules</b></p>														
Level of Blooms Taxonomy (1-6)	T-L-E modes	CLO -1	CLO 2	CLO 3	CLO 4	CLO 5	PL O 1	PL O2	PL O3	PL O4	PL O5	PL O6	PL O7	PLO 8
1 - 5	Traditional Lecture Method	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
1 - 5	Interactive Lecture Method	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2 & 4	Group Discussion	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Debate	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2 & 4	Experiential Learning	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Out-door Experiments	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2, 3, 4, 5, 6	Laboratory Work	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
1 - 5	POGIL	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1 - 5	Flipped Classroom	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2 & 4	Field based studies	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Problem Based Learning	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Project based Learning	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**Blooms Taxonomy: 1-Remembering, 2-Understanding, 3-Applying, 4-Analysing, 5-Evaluating, 6-Creating**

<p style="text-align: center;"><b>MATRIX 3</b></p> <p style="text-align: center;"><b>MAPPING TEACHING METHODS/PEDAGOGIES TO CLOs AND PLOs</b></p> <p style="text-align: center;"><b>PROGRAMME: BSc in Biotechnology</b></p> <p style="text-align: center;"><b>Course: Biostatistics</b></p>														
Level of Blooms Taxonomy (1-6)	T-L-E modes	CLO -1	CLO 2	CLO 3	CLO 4	CLO 5	PL O 1	PL O2	PL O3	PL O4	PL O5	PL O6	PL O7	PLO 8
2	Traditional Lecture Method	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
3	Interactive Lecture Method	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
3	Group Discussion	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Debate	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
3 & 4	Experiential Learning	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Out-door Experiments	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2 & 4	Laboratory Work	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	POGIL	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Flipped Classroom	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Field based studies	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Problem Based Learning	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Project based Learning	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**Blooms Taxonomy: 1-Remembering, 2-Understanding, 3-Applying, 4-Analysing, 5-Evaluating, 6-Creating**

<p style="text-align: center;"><b>MATRIX 3</b></p> <p style="text-align: center;"><b>MAPPING TEACHING METHODS/PEDAGOGIES TO CLOs AND PLOs</b></p> <p style="text-align: center;"><b>PROGRAMME: BSc in Biotechnology</b></p> <p style="text-align: center;"><b>Course: Enzymology</b></p>														
Level of Blooms Taxonomy (1-6)	T-L-E modes	CLO -1	CLO 2	CLO 3	CLO 4	CLO 5	PL O 1	PL O2	PL O3	PL O4	PL O5	PL O6	PL O7	PLO 8
2	Traditional Lecture Method	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
3	Interactive Lecture Method	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
3	Group Discussion	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Debate	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Experiential Learning	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Out-door Experiments	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2 & 4	Laboratory Work	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	POGIL	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Flipped Classroom	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Field based studies	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Problem Based Learning	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Project based Learning	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

**Blooms Taxonomy: 1-Remembering, 2-Understanding, 3-Applying, 4-Analysing, 5-Evaluating, 6-Creating**

<p style="text-align: center;"><b>MATRIX 3</b></p> <p style="text-align: center;"><b>MAPPING TEACHING METHODS/PEDAGOGIES TO CLOs AND PLOs</b></p> <p style="text-align: center;"><b>PROGRAMME: BSc in Biotechnology</b></p> <p style="text-align: center;"><b>Course: Immunology</b></p>														
Level of Blooms Taxonomy (1-6)	T-L-E modes	CLO -1	CLO 2	CLO 3	CLO 4	CLO 5	PL O 1	PL O2	PL O3	PL O4	PL O5	PL O6	PL O7	PLO 8
2	Traditional Lecture Method	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
3	Interactive Lecture Method	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
3	Group Discussion	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Debate	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Experiential Learning	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Out-door Experiments	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2 & 4	Laboratory Work	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	POGIL	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Flipped Classroom	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Field based studies	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Problem Based Learning	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Project based Learning	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

**Blooms Taxonomy: 1-Remembering, 2-Understanding, 3-Applying, 4-Analysing, 5-Evaluating, 6-Creating**

<b>MATRIX 3</b> <b>MAPPING TEACHING METHODS/PEDAGOGIES TO CLOs AND PLOs</b> <b>PROGRAMME: BSc in Biotechnology</b> <b>Course: Plant and Animal Physiology</b>														
Level of Blooms Taxonomy (1-6)	T-L-E modes	CLO -1	CLO 2	CLO 3	CLO 4	CLO 5	PL O 1	PL O2	PL O3	PL O4	PL O5	PL O6	PL O7	PLO 8
1 - 5	Traditional Lecture Method	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
1 - 5	Interactive Lecture Method	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2 & 4	Group Discussion	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Debate	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2 & 4	Experiential Learning	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Out-door Experiments	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2, 3, 4, 5	Laboratory Work	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
1 - 5	POGIL	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
1 - 5	Flipped Classroom	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2 & 4	Field based studies	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
1 - 5	Problem Based Learning	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Project based Learning	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

**Blooms Taxonomy: 1-Remembering, 2-Understanding, 3-Applying, 4-Analysing, 5-Evaluating, 6-Creating**

<p align="center"><b>MATRIX 3</b></p> <p align="center"><b>MAPPING TEACHING METHODS/PEDAGOGIES TO CLOs AND PLOs</b></p> <p align="center"><b>PROGRAMME: BSc in Biotechnology</b></p> <p align="center"><b>Course: Tools and Techniques in Biotechnology</b></p>														
Level of Blooms Taxonomy (1-6)	T-L-E modes	CLO -1	CLO 2	CLO 3	CLO 4	CLO 5	PL O 1	PL O2	PL O3	PL O4	PL O5	PL O6	PL O7	PLO 8
2	Traditional Lecture Method	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
3	Interactive Lecture Method	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
3	Group Discussion	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
3	Debate	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Experiential Learning	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Out-door Experiments	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2 & 4	Laboratory Work	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	POGIL	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2 & 3	Flipped Classroom	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Field based studies	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Problem Based Learning	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Project based Learning	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

**Blooms Taxonomy: 1-Remembering, 2-Understanding, 3-Applying, 4-Analysing, 5-Evaluating, 6-Creating**

<b>MATRIX 3</b> <b>MAPPING TEACHING METHODS/PEDAGOGIES TO CLOs AND PLOs</b> <b>PROGRAMME: BSc in Biotechnology</b> <b>Course: Molecular Genetics</b>														
Level of Blooms Taxonomy (1-6)	T-L-E modes	CLO -1	CLO 2	CLO 3	CLO 4	CLO 5	PL O 1	PL O2	PL O3	PL O4	PL O5	PL O6	PL O7	PLO 8
1-5	Traditional Lecture Method	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
1-5	Interactive Lecture Method	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
1-6	Group Discussion	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
1-5	Debate	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
1-4	Experiential Learning	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Out-door Experiments	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4-5	Laboratory Work	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	POGIL	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Flipped Classroom	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Field based studies	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1-6	Problem Based Learning	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Project based Learning	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**Blooms Taxonomy: 1-Remembering, 2-Understanding, 3-Applying, 4-Analysing, 5-Evaluating, 6-Creating**



<p align="center"><b>MATRIX 3</b></p> <p align="center"><b>MAPPING TEACHING METHODS/PEDAGOGIES TO CLOs AND PLOs</b></p> <p align="center"><b>PROGRAMME: BSc in Biotechnology</b></p> <p align="center"><b>Course: Concept in Genetic Engineering</b></p>														
Level of Blooms Taxonomy (1-6)	T-L-E modes	CLO -1	CLO 2	CLO 3	CLO 4	CLO 5	PL O 1	PL O2	PL O3	PL O4	PL O5	PL O6	PL O7	PLO 8
2	Traditional Lecture Method	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
3	Interactive Lecture Method	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
3	Group Discussion	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Debate	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Experiential Learning	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Out-door Experiments	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2 & 4	Laboratory Work	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	POGIL	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Flipped Classroom	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Field based studies	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Problem Based Learning	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Project based Learning	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

**Blooms Taxonomy: 1-Remembering, 2-Understanding, 3-Applying, 4-Analysing, 5-Evaluating, 6-Creating**

<p align="center"><b>MATRIX 3</b></p> <p align="center"><b>MAPPING TEACHING METHODS/PEDAGOGIES TO CLOs AND PLOs</b></p> <p align="center"><b>PROGRAMME: BSc in Biotechnology</b></p> <p align="center"><b>Course: Molecular Medicine</b></p>														
Level of Blooms Taxonomy (1-6)	T-L-E modes	CLO -1	CLO 2	CLO 3	CLO 4	CL O 5	PL O 1	PL O2	PL O3	PL O4	PL O5	PL O6	PL O7	PLO 8
1-5	Traditional Lecture Method	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
1-5	Interactive Lecture Method	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
1-6	Group Discussion	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
1-5	Debate	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
1-4	Experiential Learning	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Out-door Experiments	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4-5	Laboratory Work	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	POGIL	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Flipped Classroom	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Field based studies	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1-6	Problem Based Learning	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Project based Learning	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**Blooms Taxonomy: 1-Remembering, 2-Understanding, 3-Applying, 4-Analysing, 5-Evaluating, 6-Creating**

<p align="center"><b>MATRIX 3</b></p> <p align="center"><b>MAPPING TEACHING METHODS/PEDAGOGIES TO CLOs AND PLOs</b></p> <p align="center"><b>PROGRAMME: BSc in Biotechnology</b></p> <p align="center"><b>Course: Environmental Biotechnology</b></p>														
Level of Blooms Taxonomy (1-6)	T-L-E modes	CLO -1	CLO 2	CLO 3	CLO 4	CL O 5	PL O 1	PL O2	PL O3	PL O4	PL O5	PL O6	PL O7	PLO 8
1 & 2	Traditional Lecture Method	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2	Interactive Lecture Method	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2 & 3	Group Discussion	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Debate	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Experiential Learning	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Out-door Experiments	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2, 3 & 4	Laboratory Work	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	POGIL	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Flipped Classroom	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Field based studies	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Problem Based Learning	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Project based Learning	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

**Blooms Taxonomy: 1-Remembering, 2-Understanding, 3-Applying, 4-Analysing, 5-Evaluating, 6-Creating**

<p style="text-align: center;"><b>MATRIX 3</b></p> <p style="text-align: center;"><b>MAPPING TEACHING METHODS/PEDAGOGIES TO CLOs AND PLOs</b></p> <p style="text-align: center;"><b>PROGRAMME: BSc in Biotechnology</b></p> <p style="text-align: center;"><b>Course: Plant Biotechnology</b></p>														
Level of Blooms Taxonomy (1-6)	T-L-E modes	CLO -1	CLO 2	CLO 3	CLO 4	CL O 5	PL O 1	PL O2	PL O3	PL O4	PL O5	PL O6	PL O7	PLO 8
2	Traditional Lecture Method	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
3	Interactive Lecture Method	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
3 & 4	Group Discussion	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
3 & 4	Debate	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
5	Experiential Learning	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Out-door Experiments	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2 & 3	Laboratory Work	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	POGIL	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Flipped Classroom	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Field based studies	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
4 & 5	Problem Based Learning	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Project based Learning	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

**Blooms Taxonomy: 1-Remembering, 2-Understanding, 3-Applying, 4-Analysing, 5-Evaluating, 6-Creating**

<p align="center"><b>MATRIX 3</b></p> <p align="center"><b>MAPPING TEACHING METHODS/PEDAGOGIES TO CLOs AND PLOs</b></p> <p align="center"><b>PROGRAMME: BSc in Biotechnology</b></p> <p align="center"><b>Course: Bioinformatics</b></p>														
Level of Blooms Taxonomy (1-6)	T-L-E modes	CLO -1	CLO 2	CLO 3	CLO 4	CL O 5	PL O 1	PL O2	PL O3	PL O4	PL O5	PL O6	PL O7	PLO 8
1 & 2	Traditional Lecture Method	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2	Interactive Lecture Method	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2 & 3	Group Discussion	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
3	Debate	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2 & 4	Experiential Learning	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Out-door Experiments	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2, 3 & 4	Laboratory Work	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	POGIL	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2 & 3	Flipped Classroom	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Field based studies	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Problem Based Learning	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Project based Learning	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**Blooms Taxonomy: 1-Remembering, 2-Understanding, 3-Applying, 4-Analysing, 5-Evaluating, 6-Creating**

<p align="center"><b>MATRIX 3</b></p> <p align="center"><b>MAPPING TEACHING METHODS/PEDAGOGIES TO CLOs AND PLOs</b></p> <p align="center"><b>PROGRAMME: BSc in Biotechnology</b></p> <p align="center"><b>Course: Industrial Biotechnology</b></p>														
Level of Blooms Taxonomy (1-6)	T-L-E modes	CLO -1	CLO 2	CLO 3	CLO 4	CL O 5	PL O 1	PL O2	PL O3	PL O4	PL O5	PL O6	PL O7	PLO 8
1 - 5	Traditional Lecture Method	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
1 - 5	Interactive Lecture Method	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2 & 4	Group Discussion	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Debate	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2 & 4	Experiential Learning	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Out-door Experiments	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2, 3, 4, 5	Laboratory Work	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	POGIL	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Flipped Classroom	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Field based studies	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Problem Based Learning	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Project based Learning	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**Blooms Taxonomy: 1-Remembering, 2-Understanding, 3-Applying, 4-Analysing, 5-Evaluating, 6-Creating**

<p style="text-align: center;"><b>MATRIX 3</b></p> <p style="text-align: center;"><b>MAPPING TEACHING METHODS/PEDAGOGIES TO CLOs AND PLOs</b></p> <p style="text-align: center;"><b>PROGRAMME: BSc in Biotechnology</b></p> <p style="text-align: center;"><b>Course: Bioethics and Biosafety</b></p>														
Level of Blooms Taxonomy (1-6)	T-L-E modes	CLO -1	CLO 2	CLO 3	CLO 4	CL O 5	PL O 1	PL O2	PL O3	PL O4	PL O5	PL O6	PL O7	PLO 8
1 & 2	Traditional Lecture Method	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2	Interactive Lecture Method	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2 & 3	Group Discussion	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Debate	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2 & 4	Experiential Learning	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Out-door Experiments	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2, 3, 4 & 6	Laboratory Work	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	POGIL	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2 & 3	Flipped Classroom	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Field based studies	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Problem Based Learning	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Project based Learning	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

**Blooms Taxonomy: 1-Remembering, 2-Understanding, 3-Applying, 4-Analysing, 5-Evaluating, 6-Creating**

<p align="center"><b>MATRIX 3</b></p> <p align="center"><b>MAPPING TEACHING METHODS/PEDAGOGIES TO CLOs AND PLOs</b></p> <p align="center"><b>PROGRAMME: BSc in Biotechnology</b></p> <p align="center"><b>Course: Advanced Microbiology</b></p>														
Level of Blooms Taxonomy (1-6)	T-L-E modes	CLO -1	CLO 2	CLO 3	CLO 4	CL O 5	PL O 1	PL O2	PL O3	PL O4	PL O5	PL O6	PL O7	PLO 8
1 & 2	Traditional Lecture Method	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2	Interactive Lecture Method	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2 & 3	Group Discussion	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Debate	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Experiential Learning	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Out-door Experiments	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2, 3 & 4	Laboratory Work	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	POGIL	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2 & 3	Flipped Classroom	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Field based studies	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Problem Based Learning	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Project based Learning	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

**Blooms Taxonomy: 1-Remembering, 2-Understanding, 3-Applying, 4-Analysing, 5-Evaluating, 6-Creating**

<p align="center"><b>MATRIX 3</b></p> <p align="center"><b>MAPPING TEACHING METHODS/PEDAGOGIES TO CLOs AND PLOs</b></p> <p align="center"><b>PROGRAMME: BSc in Biotechnology</b></p> <p align="center"><b>Course: Animal Cell Culture</b></p>														
Blooms Taxonomy	T-L-E modes	CLO -1	CLO 2	CLO 3	CLO 4	CLO 5	PL O 1	PL O2	PL O3	PL O4	PL O5	PL O6	PL O7	PLO 8
1-5	Traditional Lecture Method	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
1-5	Interactive Lecture Method	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
1-6	Group Discussion	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
1-5	Debate	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
1-4	Experiential Learning	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Out-door Experiments	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4-5	Laboratory Work	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	POGIL	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Flipped Classroom	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Field based studies	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1-6	Problem Based Learning	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Project based Learning	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**Blooms Taxonomy: 1-Remembering, 2-Understanding, 3-Applying, 4-Analysing, 5-Evaluating, 6-Creating**

[illegible]

<b>MATRIX 4</b> <b>MAPPING ASSESSMENT MODES TO CLOs AND PLOs</b> <b>PROGRAMME: BSc in Biotechnology Course: Cell Biology</b>														
<b>Blooms Taxonomy</b>	<b>T-L-E modes</b>	<b>CLO-1</b>	<b>CLO 2</b>	<b>CLO 3</b>	<b>CLO 4</b>	<b>CL 05</b>	<b>PL 01</b>	<b>PL 02</b>	<b>PL 03</b>	<b>PL 04</b>	<b>PL 05</b>	<b>PL 06</b>	<b>PL 07</b>	<b>PL 08</b>
4	Problem Based Learning	☑	☑	☑	☑	☒	☑	☑	☑	☑	☑	☒	☑	☑
6	Project based Learning	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
3	Student Seminars	☑	☑	☒	☒	☒	☑	☒	☑	☑	☑	☒	☑	☑
5	Case Studies	☑	☑	☑	☑	☒	☑	☑	☑	☑	☑	☒	☑	☑
3	Student Presentations	☑	☑	☒	☒	☒	☑	☒	☑	☑	☑	☒	☑	☑
	Gobbet	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
5	Assignments	☑	☑	☒	☒	☒	☑	☒	☑	☑	☑	☒	☑	☑
5	Open Book Exam	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
4	SAQs	☑	☑	☑	☑	☒	☑	☑	☑	☑	☑	☒	☑	☑
4	MCQs	☑	☑	☑	☑	☒	☑	☑	☑	☑	☑	☒	☑	☑
	Portfolio	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	Concept Maps	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
5	Research Based Analysis	☑	☑	☑	☑	☒	☑	☑	☑	☑	☑	☒	☑	☑
	Enacting /Roleplay	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
5	Summative term and exam	☑	☑	☑	☑	☒	☑	☑	☑	☑	☑	☒	☑	☑
4	Laboratory practical	☑	☑	☑	☑	☑	☑	☒	☑	☑	☑	☒	☑	☑
6	Research project	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

<b>MATRIX 4</b> <b>MAPPING ASSESSMENT MODES TO CLOs AND PLOs</b> <b>PROGRAMME: BSc in Biotechnology Course: Fundamental Genetics</b>														
<b>Blooms Taxonomy</b>	<b>T-L-E modes</b>	<b>CLO-1</b>	<b>CLO 2</b>	<b>CLO 3</b>	<b>CLO 4</b>	<b>CL 05</b>	<b>PL 01</b>	<b>PL 02</b>	<b>PL 03</b>	<b>PL 04</b>	<b>PL 05</b>	<b>PL 06</b>	<b>PL 07</b>	<b>PL 08</b>
4	Problem Based Learning	☑	☑	☑	☑	☒	☑	☑	☑	☑	☑	☒	☑	☑
6	Project based Learning	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
3	Student Seminars	☑	☑	☒	☒	☒	☑	☒	☑	☑	☑	☒	☑	☑
5	Case Studies	☑	☑	☑	☑	☒	☑	☑	☑	☑	☑	☒	☑	☑
3	Student Presentations	☑	☑	☒	☒	☒	☑	☒	☑	☑	☑	☒	☑	☑
	Gobbet	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
5	Assignments	☑	☑	☒	☒	☒	☑	☒	☑	☑	☑	☒	☑	☑
5	Open Book Exam	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
4	SAQs	☑	☑	☑	☑	☒	☑	☑	☑	☑	☑	☒	☑	☑
4	MCQs	☑	☑	☑	☑	☒	☑	☑	☑	☑	☑	☒	☑	☑
	Portfolio	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	Concept Maps	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
5	Research Based Analysis	☑	☑	☑	☑	☒	☑	☑	☑	☑	☑	☒	☑	☑
	Enacting /Roleplay	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
5	Summative term and exam	☑	☑	☑	☑	☒	☑	☑	☑	☑	☑	☒	☑	☑
4	Laboratory practical	☑	☑	☑	☑	☑	☑	☒	☑	☑	☑	☒	☑	☑

## MATRIX 4

## MAPPING ASSESSMENT MODES TO CLOs AND PLOs

**PROGRAMME: BSc in Biotechnology Course: Basic Microbiology**

[illegible]

## MATRIX 4

## MAPPING ASSESSMENT MODES TO CLOs AND PLOs

**PROGRAMME: BSc in Biotechnology Course: Molecular Biology**[illegible]

[illegible][illegible]



**MATRIX 4**  
**MAPPING ASSESSMENT MODES TO CLOs AND PLOs**  
**PROGRAMME: BSc in Biotechnology Course: Biostatistics**

[illegible]

**MATRIX 4**  
**MAPPING ASSESSMENT MODES TO CLOs AND PLOs**  
**PROGRAMME: BSc in Biotechnology Course: Enzymology**

[illegible]

**MATRIX 4**  
**MAPPING ASSESSMENT MODES TO CLOs AND PLOs**  
**PROGRAMME: BSc in Biotechnology Course: Immunology**

[illegible]

**MATRIX 4**  
**MAPPING ASSESSMENT MODES TO CLOs AND PLOs**  
**PROGRAMME: BSc in Biotechnology Course: Plant and Animal Physiology**

[illegible]

## MATRIX 4

## MAPPING ASSESSMENT MODES TO CLOs AND PLOs

**PROGRAMME: BSc in Biotechnology Course: Tools and Techniques in Biotechnology**

[illegible]

## MATRIX 4

## MAPPING ASSESSMENT MODES TO CLOs AND PLOs

**PROGRAMME: BSc in Biotechnology Course: Molecular Genetics**

[illegible]

<p align="center"><b>MATRIX 4</b></p> <p align="center"><b>MAPPING ASSESSMENT MODES TO CLOs AND PLOs</b></p> <p align="center"><b>PROGRAMME: BSc in Biotechnology Course: Concept in Genetic Engineering</b></p>	
--	--

<p align="center"><b>MATRIX 4</b></p> <p align="center"><b>MAPPING ASSESSMENT MODES TO CLOs AND PLOs</b></p> <p align="center"><b>PROGRAMME: BSc in Biotechnology Course: Molecular Medicine</b></p>	
--	--

[illegible]

## MATRIX 4

## MAPPING ASSESSMENT MODES TO CLOs AND PLOs

**PROGRAMME: BSc in Biotechnology Course: Environmental Biotechnology**

[illegible]

## MATRIX 4

## MAPPING ASSESSMENT MODES TO CLOs AND PLOs

**PROGRAMME: BSc in Biotechnology Course: Plant Biotechnology**[illegible]

**MATRIX 4**  
**MAPPING ASSESSMENT MODES TO CLOs AND PLOs**  
**PROGRAMME: BSc in Biotechnology Course: Bioinformatics**

[illegible]

**MATRIX 4**  
**MAPPING ASSESSMENT MODES TO CLOs AND PLOs**  
**PROGRAMME: BSc in Biotechnology Course: Industrial Biotechnology**

[illegible]



<b>MATRIX 4</b> <b>MAPPING ASSESSMENT MODES TO CLOs AND PLOs</b> <b>PROGRAMME: BSc in Biotechnology Course: Animal cell culture</b>														
<b>Blooms Taxonomy</b>	<b>T-L-E modes</b>	<b>CLO-1</b>	<b>CLO 2</b>	<b>CLO 3</b>	<b>CLO 4</b>	<b>CL O5</b>	<b>PL O1</b>	<b>PL O2</b>	<b>PL O3</b>	<b>PL O4</b>	<b>PL O5</b>	<b>PL O6</b>	<b>PL O7</b>	<b>PL O8</b>
4	Problem Based Learning	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
6	Project based Learning	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3	Student Seminars	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
5	Case Studies	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
3	Student Presentations	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Gobbet	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5	Assignments	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
5	Open Book Exam	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4	SAQs	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
4	MCQs	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Portfolio	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Concept Maps	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5	Research Based Analysis	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Enacting /Roleplay	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5	Summative term and exam	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
4	Laboratory practical	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
6	Research project	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

\*\*\*\*\*