Academic Council Meeting No. and Date: 9 / July 02, 2024
Agenda Number: 3 Resolution Number: 41, 42/ 3.8, 3.28

Vidya Prasarak Mandal's
B. N. Bandodkar College of Science
(Autonomous), Thane

Syllabus for

Programme Code : BUBT
Programme: Bachelor of Science

Specific Programme: Biotechnology

[S.Y.B.Sc. Biotechnology]
Level 5.0
CHOICE BASED GRADING SYSTEM

Revised under NEP
From academic year 2024 - 2025

Preamble

Biotechnology is an applied branch of biology that includes the study of biological systems to develop or create different products for betterment of society. Microbiology, biochemistry, immunology, genetics, molecular biology, medicine (drug development and personalized therapies), agriculture, marine, industrial biotechnology are among many other fields that form a beautiful collage of Biotechnology.

The present revision is related to restructuring of syllabus under the National Education Policy 2020, which aims at the holistic development of learners. With Biotechnology and Microbiology as major and minor subjects respectively, the students would learn concepts in biophysics, biochemistry, tissue culture, medical microbiology, immunology and molecular techniques. Generic courses include molecular biology, population genetics and cell-cell interactions. To improve scientific expression of the learner, a module covering research methodology has been introduced. A unit on entrepreneurship has been designed in order to introduce them to the various skills required to become a successful entrepreneur. Units on digital skills and employment communication have been newly introduced to make them job- ready in near future. Role of Biotechnology on environment management would be dealt with as a part of 'Value education'. In addition to these, the student would also be required to undertake 60 hours of field projects in order to encourage field-based learning; or Community engagement and service (sports activity/ cultural committee/ NSS/ NCC/ DLLE work).

The revised curriculum aims to impart basic knowledge with emphasis on its applications to make the students research and industry ready.

Prof. Dr. Jayashree Pawar
Chairperson, BOS Biotechnology
VPM's B.N.Bandodkar College of Science (Autonomous), Thane

PROGRAMME OUTCOMES (POs) OF BACHELOR OF SCIENCE (B.Sc.)

The Undergraduate Programmes of Science are intended to cater quality education and attain holistic development of learners through the following programme outcomes*:*

PO1 - Disciplinary Knowledge

Lay a strong foundation of conceptual learning in science. Instil ability to apply science in professional, social and personal life.

PO2 - Inculcation of Research Aptitude

Ignite spirit of inquiry, critical thinking, analytical skills and problem-solving approach which will help learners to grasp concepts related to research methodology and execute budding research ideas.

PO3 - Digital Literacy

Enhance ability to access, select and use a variety of relevant information e-resources for curricular, co-curricular and extracurricular learning processes.

PO4 - Sensitization towards Environment

Build a cohesive bond with nature by respecting natural resources, encouraging eco-friendly practices and creating awareness about sustainable development.

PO5 - Individuality and Teamwork

Encourage learners to work independently or in collaboration for achieving effective results through practical experiments, project work and research activities.

PO6 - Social and Ethical Awareness

Foster ethical principles which will help in developing rational thinking and becoming sociallyawarecitizens. Build an attitude of unbiased, truthful actions and avoid unethical behaviour in all aspects of life.

Eligibility: Passed F. Y. B.Sc. in Biotechnology (Major)
Degree Programme: B.Sc. Duration: 1 Year (includes SEM III and SEM IV)
Mode of Conduct: Offline Laboratory Practicals / Offline lectures / Online lectures
Specific Programme: S.Y.B.Sc. Biotechnology
Qualification Title: UG Diploma

Discipline/Subject: **BIOTECHNOLOGY**

Program Specific Outcomes		
1	Recall and define fundamental concepts of biomolecules, cells, genes, enzymes, recombinant DNA technology, and basic molecular and cellular mechanisms underlying biotechnology.	L1
2	Explain the principles, workflows, and biosafety practices involved in standard biotechnological, molecular biology, biochemical, microbiological, and bioinformatics techniques.	L2
3	Apply biotechnological principles to industrial, medical, agricultural, environmental, and pharmaceutical contexts, demonstrating how biological systems are engineered for specific biotechnological applications.	L3
4	Analyze and interpret biological and experimental data related to health and disease, including diagnostic, immunological, genomic, and therapeutic aspects of clinical and biomedical biotechnology.	L4
5	Evaluate biotechnological problems using critical thinking, data interpretation, and bioinformatic tools to propose feasible, evidence-based, and ethically sound solutions.	L5
6	Design and propose innovative biotechnological approaches to address societal, industrial, and environmental challenges, with emphasis on sustainability, public health, and community welfare.	L6

Specific Programme: S.Y.B.Sc. (Biotechnology)		
Assessment: Weightage for assessments (in percentage) For Major and Minor		
Type of Course	Formative Assessment / IA	Summative Assessment
Theory	40 %	60 %

VPM'S B. N. Bandodkar College of Science
(Autonomous), Thane
S.Y.B.Sc. (Biotechnology)
Structure of Programme

Semester III: (Major)				
	Course Code	**Course Title**	**No. of lectures In hrs.**	**Credits**
Major	24BUBT3T01	Biochemistry I	30	2
	24BUBT3T02	Fundamentals of Biophysics	30	2
	24BUBT3T03	Plant and Animal Tissue Culture	30	2
	24BUBT3P01	Practicals based on 24BUBT3T01 and 24BUBT3T02	60	2
	24BUBT3P02	Practicals based on 24BUBT3T02 and 24BUBT3T03	60	2
SEC	24BU3SEC07	Microbial Diseases & Conventional Laboratory Diagnosis	45	2
Minor	24BUBT3T04	Infectious Diseases and Chemotherapy	30	2
Generic	24BUBT3T05	Molecular Biology I	30	2
AEC	24BU3AEC04	Research Methodology	30	2
VEC	24BU3VEC04	Environmental Biotechnology II	30	2
FP or CC	24BUBT3P03	Field Project in Biotechnology II	60	2
	23BU3CC606	Departmental Activities II	60	2
		Total	**435**	**22**

Semester IV				
	Course Code	**Course Title**	**No. of lectures In hrs.**	**Credits**
Major	24BUBT4T01	Biochemistry II	30	2
	24BUBT4T02	Immunology	30	2
	24BUBT4T03	Molecular Techniques	30	2
	24BUBT4P01	Practicals based on 24BUBT4T01 and24BUBT4T02	60	2
	24BUBT4P02	Practicals based on 24BUBT4T02 and 24BUBT4T03	60	2
SEC	24BU4SEC07	Digital Skills	45	2
Minor	24BUBT4T04	Fermentation Technology	30	2
Generic	24BUBT4T05	Population Genetics and Cell-cell interactions	30	2
AEC	24BU4AEC04	Employment communication and Entrepreneurship	30	2
VEC	24BU4VEC01	Environmental Biotechnology III	30	2
FP or CC	24BUBT4P03	Field Project in Biotechnology III	60	2
	23BU4CC606	Departmental Activities III	60	2
		Total	**435**	**22**

Semester III

Course Code: 24BUBT3T01	Course Title Biochemistry I	Credits (02)	No. of Lectures in hours

COURSE OUTCOME

On completion of this course, students will be able to learn:

CO1	Describe the structure and functional roles of membrane lipids, proteins, and diffusion mechanisms in regulating selective transport across the cell membrane.	L2
CO2	Apply principles of active transport and membrane permeability to illustrate substrate uptake mechanisms involving pumps, transporters, channels, and liposomes.	L3
CO3	Explain the classification, properties, and catalytic mechanisms of enzymes, along with the influence of environmental factors on their activity.	L2
CO4	Apply enzyme kinetics and inhibition principles to interpret multi-substrate reactions and regulatory mechanisms involving cofactors and isozymes.	L3

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	0	0	0	0	0
CO2	3	0	0	0	0	0
CO3	3	0	0	0	2	0
CO4	3	1	0	0	2	0

Units	Description	No. of lectures
Unit I: Membrane transport	1.1 Cell Membrane a. Biomedical importance b. The Major Lipids in Mammalian Membranes c. Membrane Lipids Are Amphipathic d. Membrane Lipids Form Bilayers e. Membrane Proteins f. Cell membrane as selective barrier 1.2 Diffusion a. Passive Diffusion b. Facilitated Diffusion 1.3 Types of Transport proteins: Carrier and channels 1.4 Active transport: a. Types- Primary and Secondary active b. ABC transporters as an example of primary active transport c. Types of secondary active transport (Co-transport) d. Lactose permease as an example of secondary active transport	**15**

	1.5 Sodium Potassium Pump 1.6 Ion channels, ionophores and aquaporins 1.7 Siderophores: Significance and examples 1.8 Utilization of Substrates that cannot pass the cell membrane 1.9 Liposomes: Definition and significance	
Unit II: Basic Enzymology	2.1 History, Definition, Classification and Nomenclature of enzymes 2.2 Chemical Nature, Properties of Enzymes 2.3 Mechanism of Enzyme Action 2.4 Active Sites, Enzyme Specificity 2.5 Effect of pH, Temperature, Substrate Concentration on Enzyme Activity 2.6 Enzyme Kinetics: Michelis-Menten Equation 2.7 Types of Enzyme Inhibitions-Competitive, Uncompetitive, Non-Competitive 2.8 Allosteric Modulators Co-Factors, Zymogens and isozymes, 2.9 Kinetics of multi-substrate reactions	**15**

Course Code: 24BUBT3T02	Course Title Fundamentals of Biophysics	Credits (02)	No. of Lectures in hours

COURSE OUTCOME

On completion of this course, students will be able to learn:

CO1	Explain the wave nature of light and the principles and biomedical applications of LASER.	L2
CO2	Describe UV-Visible spectroscopy and advanced microscopy techniques with their biological applications.	L2
CO3	Explain principle and working of temperature measurement and types of sound waves with applications in sonication.	L2
CO4	Describe magnetic properties and biomagnetic fields, and explain fluid dynamics in biological systems.	L2

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	0	0	2	0
CO2	3	3	0	0	3	0
CO3	2	0	0	0	0	0
CO4	1	1	0	0	0	0

Units	Description	No. of lectures
Unit I: Optics and electromagnetic radiations	1.1 Introduction to Optics and Laser: a. Nature and Properties of Light: Day-to-day applications, Introduction to Light waves, Characteristics of light waves, Properties of light (Reflection, Refraction, Dispersion, Interference, Absorption, Diffraction, Scattering). b. LASER: Application of Laser in medicine, The Effects of Lasers on Biological Tissues, Applications to Biological Tissues (Only Optical tweezers), Interaction of light with matter (Absorption, Spontaneous emission, Stimulated emission), Laser beam characteristics. 1.2 Introduction to Electromagnetic Radiations: Spectroscopy: Properties of electromagnetic radiation, Interaction with matter, UV-visible light spectroscopy (chromophores, principle, instrumentation, Applications).	**15**

	1.3 Microscopy: Electron microscopy (TEM, SEM), Fluorescence Microscopy, Confocal Microscopy, Scanning Probe Microscopy.	
Unit II: Heat, Sound, Magnetism and Fluid dynamics	2.1 Heat: Measuring Temperature: Mercury in glass thermometer, electrical resistance thermometer, Thermocouple (Principle, Construction, Working). 2.2 Sound: Sonicator, Types of Sound Waves - Audible, Ultrasonic and Infrasonic Waves. 2.3 Magnetism: Introduction, Magnetic properties of materials (Para-magnetism, Diamagnetism, Ferromagnetism); Bio-magnetic fields and the human body. 2.4 Fluid Dynamics: a. Viscosity: Stokes' Law; Measurement of viscosity, Applications of viscometry, Significance of viscosity in biological systems b. Surface Tension: Surface energy, Surface energy and Surface tension, Angle of contact, Capillary rise, Detergent and surface tension, significance of wettability in contact lenses	**15**

Course Code: 24BUBT3T03	Course Title Plant and Animal Tissue Culture	Credits (02)	No. of Lectures in hours

COURSE OUTCOME

On completion of this course, students will be able to learn:

CO1	Describe the layout of a tissue culture lab and explain the types and preparation of culture media.	L2
CO2	Explain aseptic plant tissue culture procedures and describe the principles of callus culture and organogenesis.	L2
CO3	Describe the laboratory design, essential equipment, sterilization protocols, and media used in animal tissue culture along with its different types.	L2
CO4	Explain the steps involved in cell line handling, growth curve phases, cytotoxicity assays, and scale-up techniques in animal tissue culture.	L2

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	1	3	2
CO2	3	3	1	1	3	2
CO3	3	1	1	0	0	0
CO4	3	1	1	0	0	0

Units	Description	No. of lectures
Unit I: Plant Tissue Culture	1.1 Introduction 1.2 Tissue Culture Laboratory: a. General Laboratory b. Laboratory for aseptic inoculation c. Culture room d. Glass goods and instruments 1.3 Plant tissue culture media a. Culture medium and the preparation of stock solution b. Selection of new medium 1.4 Techniques in plant tissue culture: a. Preparation of Culture Medium b. Sterilization procedure c. Preparation of aseptic plants d. Aseptic techniques e. Incubation of culture 1.5 Callus Culture: 1. Introduction 2. Principle	**15**

	3. Protocol 4. How is the callus tissue formed? 5. Morphology, internal structure and other characteristics of callus culture 6. Significance of callus culture 1.6 Organogenesis	
Unit II: Animal Tissue Culture	2.1 Introduction to animal tissue culture and its types 2.2 Design of ATC laboratory 2.3 Glassware, plasticware and Equipment for ATC 2.4 Sterilization protocols 2.5 Tissue culture media 2.6 Culture of cell lines: a. Procurement b. Initiation, c. Evolution, d. Maintenance e. Phases and growth curve f. Subculturing g. Cryopreservation 2.7 Applications & Limitations of Cell Cultures 2.8 Cell proliferation and cytotoxicity assays: principle and significance 2.9 Cell culture-scale up and automation	**15**

Course Code 24BUBT3P01	Course Title Practical based on 24BUBT3T01 and 24BUBT3T02	Credits (02)	No. of Lectures in hours 60

COURSE OUTCOME

Students will be able to learn OR on completion of this course, students will be able to learn:

CO1	Perform biochemical assays such as alkaline phosphatase activity, determine absorption maxima and apply Beer–Lambert's law for spectrophotometric analysis.	L3
CO2	Solve problems related to stock solution calculations and formulate plant tissue culture media based on specified compositions.	L4
CO3	Explain the principles of UV spectrophotometric analysis for nucleic acid quantification and the methods of surface sterilization and aseptic explant preparation.	L2
CO4	Describe the principles, protocols and significance of callus culture, organogenesis and synthetic seed production in plant tissue culture.	L2

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	1	0	2	0
CO2	3	1	1	0	1	0
CO3	3	1	1	1	2	0
CO4	3	1	1	1	2	0

Practical No.	Name of the experiment
Practical 1	Study of Absorption Spectra of Colored Compounds ($CuSO_4$, $CoCl_2$, $KMnO_4$)
Practical 2	Verification of Beer-Lambert's Law
Practical 3	Determination of Purity and Concentration of nucleic acids using UV Spectrophotometry
Practical 4	Study of alkaline phosphatase enzyme kinetics using spectrophotometer
Practical 5	Preparation of Stock Solutions and Preparation of Media for PTC
Practical 6	Surface Sterilization and raising sterile explants
Practical 7	Callus Culture
Practical 8	Organogenesis: Induction of roots and shoots
Practical 9	Synthetic seed production

Course Code 24BUBT3P02	Course Title Practical based on 24BUBT3T02 and 24BUBT3T03	Credits (02)	No. of Lectures in hours 60

COURSE OUTCOME		
Students will be able to learn OR on completion of this course, students will be able to learn:		
CO1	Interpret enzyme activity through graphical analysis of enzyme kinetics, evaluating the effects of temperature, pH, substrate concentration, and inhibitors.	L3
CO2	Analyze the effects of sonication on cell samples and evaluate cell viability and density using haemocytometer counting and trypan blue staining.	L4
CO3	Explain the principles, structure, and applications of fluorescence and electron microscopes, including sample preparation and staining procedures.	L2
CO4	Describe the mechanisms of cell lysis by sonication and analyze the osmotic fragility of red blood cells in hypotonic conditions.	L2

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	1	0	2	0
CO2	3	1	1	0	2	0
CO3	3	1	1	1	0	0
CO4	3	1	1	1	0	0

Practical No.	Name of the experiment
Practical 1	Enzyme Kinetics: a. Study of the effect of Temperature on activity of Enzyme b. Study of the effect of pH on activity of Enzyme c. Study of Effect of Substrate Concentration on enzyme activity d. and determination of Vmax and Km e. Effect of inhibitors on enzyme activity: Competitive, f. Uncompetitive, Non-Competitive
Practical 2	Demonstration of Structure and Working of a Fluorescence Microscope (Stained Preparation)
Practical 3	Study of the Structure and Function of an Electron Microscope (Visit / Video Demonstration - including Sample Preparation and Staining)
Practical 4	Cell lysis using sonicator.
Practical 5	Study of osmotic fragility of RBCs
Practical 6	Graph plotting and reading: Principles, dos and don’ts
Practical 7	Counting of cells during passaging using Haemocytometer.

Course Code: 24BUBT3T04	Course Title Infectious Diseases and Chemotherapy	Credits (02)	No. of Lectures in hours

COURSE OUTCOME

On completion of this course, students will be able to learn:

CO1	Explain the concepts of normal microbiota and principles of microbial pathogenicity, including the role of virulence, toxigenicity, and opportunistic microorganisms in infectious diseases.	L2
CO2	Analyze the mechanisms of bacterial pathogenesis, patterns of disease, and the spread of infections, incorporating concepts such as nosocomial infections and pathogenicity islands	L4
CO3	Explain the classification, selective toxicity, and modes of action of antimicrobial agents targeting cell wall synthesis, plasma membrane and protein synthesis.	L2
CO4	Illustrate using suitable examples, the modes of action of antimicrobial agents targeting nucleic acid synthesis and metabolic pathways and mechanisms of drug resistance.	L3

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	0	1	0
CO2	3	2	1	0	1	0
CO3	3	2	1	1	1	0
CO4	3	2	1	1	1	0

Units	Description	No. of lectures
Unit I: Infectious Diseases	1.1 a. Pathology, Infection, and Disease b. Normal microbiota of human body (Refer only the table) Gnotobiotic Animals, 1.2 Microbiome (Definition only) a. Virulence (Definition only) and Toxigenicity b. Opportunistic Microorganisms 1.3 The Etiology of Infectious Diseases 1.4 Classifying Infectious Diseases 1.5 Overview of bacterial pathogenesis 1.6 Patterns of Disease 1.7 The Spread of Infection 1.8 Pathogenicity Islands (definition only), Nosocomial infections 1.9 Molecular Koch's Postulates	**15**
Unit II: Chemotherapy	2.1 a. Discovery and Design of antimicrobial agents b. Classification of Antibacterial agents, Selective toxicity, MIC, MLC	**15**

	2.2 Inhibition of cell wall synthesis (Mode of action for): Beta lactam antibiotics: Penicillin, Cephalosporins; Glycopeptides: Vancomycin 2.3 Polypeptide antibiotic: Bacitracin 2.4 Injury to Plasma membrane: Polymyxin 2.5 Inhibition of protein synthesis: Aminoglycosides, Tetracyclines Chloramphenicol, Macrolides-Erythromycin 2.6 Inhibition of Nucleic acid synthesis: Quinolones, Rifampicin 2.7 Antimetabolites: Sulphonamides, Trimethoprim 2.8 Drug Resistance: a. Mechanism, Origin and transmission of drug resistance b. Use and misuse of antimicrobial agents 2.9 Antifungal drugs, Antiviral drugs	

Course Code: 24BUBT3T05	Course Title Molecular Biology I	Credits (02)	No. of Lectures in hours

COURSE OUTCOME

On completion of this course, students will be able to learn:

CO1	Explain the significance of DNA as genetic material, Meselson and Stahl experiment, Okazaki experiment along with mechanisms of bidirectional replication and the molecular model of DNA replication in E. coli.	L2
CO2	Illustrate the mechanisms of rolling circle replication, eukaryotic DNA replication and the role of telomerase in replicating chromosome ends.	L3
CO3	Describe the fundamental differences between replication and transcription; transcription process in prokaryotes.	L2
CO4	Illustrate the transcription process in eukaryotes along with production of mature mRNA, RNA editing.	L3

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	1	0	0	0
CO2	3	1	1	0	0	0
CO3	3	0	1	0	0	0
CO4	3	0	1	0	0	0

Units	Description	No. of lectures
Unit I: Replication	1.1 Importance of DNA as genetic material 1.2 Organization of prokaryotic and eukaryotic chromosomes 1.3 DNA replication in prokaryotes and eukaryotes- a. Semi-conservative DNA replication: Meselson and Stahl Experiment b. Role of different proteins and enzymes in DNA replication: Initiator proteins, Helicases, Primase, SSBPs, DNA Gyrase, DNA ligase c. Semi-discontinuous Replication: The Okazaki experiment d. Bidirectional Replication of circular DNA molecules, e. Molecular model of DNA Replication in *E.coli*: Initiation, elongation and termination of replication f. DNA polymerases and their role	**15**

	g. Rolling circle replication h. DNA replication in Eukaryotes: Replicons, Initiation of replication, replication enzymes i. Replicating the ends of chromosomes, telomerase (action and significance)	
Unit II: Transcription	2.1 Central dogma of molecular biology 2.2 Gene Expression- an Overview: a. Fundamental difference in replication and transcription, its significance b. Bacterial gene structure, concept of 'consensus sequence' c. Bacterial RNA polymerases d. Transcription Process in Prokaryotes: Initiation, elongation, termination (rho dependent and independent) e. Coupled transcription and translation, polycistronic RNA in bacteria f. Transcription in Eukaryotes: Types of RNA molecules; Eukaryotic RNA Polymerases g. Eukaryotic Promoter, PPE, enhancer; introduction to concept of *'in cis*' and *'in trans'* action h. Transcription of Protein Coding Genes by RNA Polymerase II i. Production of Mature mRNA in Eukaryotes: 5' and 3' end modifications j. Introns, splicing of group II introns, overlapping genes, Significance of splicing k. RNA editing and its significance	**15**

Course Code: 24BU3AEC04	Course Title Research Methodology	Credits (02)	No. of Lectures in hours

COURSE OUTCOME

On completion of this course, students will be able to learn:

CO1	Apply the principles of research methodology. Understand the fundamental concepts of research including its meaning, objectives, motivation, types, approaches, significance and evaluate the criteria of good research.	L3
CO2	Identify a research problem. Apply the research process to formulate research problems, identify variables, construct hypotheses, and research design.	L3
CO3	Explain various methods for collecting primary and secondary data, including observation, interviews, questionnaires, and case studies.	L6
CO4	Explain sampling strategies in qualitative and quantitative research, and outline the key components of successful research grant applications and international collaborations.	L6

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	0	0	1	0
CO2	2	3	0	0	2	0
CO3	2	3	1	0	2	0
CO4	2	3	1	0	2	0

Units	Description	No. of lectures
Unit I: Introduction and Research design	1.1 Meaning of Research, Objectives & Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research methods Vs. Methodology 1.2 Research Process, Criteria of Good Research 1.3 Review of literature, formulating a research problem, identifying variables, Constructing hypothesis. 1.4 Research Design: Meaning, need and features of a good design Basic principle of experimental design, Important concepts relating to Research Design, differences between quantitative and qualitative study designs, commonly used designs	**15**
Unit II: Data Collection for research	2.1 Collection of Primary Data: Observation Method, Interview Method, Collection of data through questionnaires / schedules, other methods of data collection	**15**

	2.2 Collection of secondary data, Selection of appropriate method for data collection, case study method 2.3 Selecting a sample: Differences between sampling in qualitative and quantitative research, definitions of sampling terminology, Factors affecting the inferences drawn from a sample, Different types of sampling including: Random/probability sampling designs Non-random/non- probability sampling designs, 'mixed' sampling design, Sample size 2.4 Research Grants: Guide to grant applications; What goes into successful research grant? International research collaborations	

Course Code: 24BU3SEC07	Course Title Microbial Diseases & Conventional Laboratory Diagnosis	Credits (01)	No. of Lectures 15

COURSE OUTCOME

Students will be able to learn OR on completion of this course, students will be able to learn:

CO1	Explain the causative agents, symptoms and management strategies for respiratory tract infections, skin infections and vector borne disease	L2
CO2	Describe the pathogenesis and clinical management of infections caused by Salmonella typhi, E. coli, uropathogenic bacteria and Candida albicans, with an emphasis on prevention and treatment.	L2
CO3	Identify the causative agents of representative diseases.	L4
CO4	Determine the sensitivity of a pathogen towards different antibiotics	L5

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	0	0	1	0
CO2	3	2	0	0	1	0
CO3	3	1	1	0	2	0
CO4	3	1	1	0	2	0

Units	Description	No. of lectures
Unit I: Microbial Diseases	1.1 Respiratory Tract Infection: *M. tuberculosis* (Management of TB, Prevention and Control, Immuno and Chemoprophylaxis, DOTS and MDR) 1.2 Skin Infections: *S. aureus, S. pyogenes* 1.3 GI Tract Infections: *Salmonella typhi, E. coli.* 1.4 Urinary Tract Infections: Uropathogenic *E. coli* and *Proteus* 1.5 Vector Borne disease: Dengue 1.6 Yeast infection: *Candida albicans*	**15**

Course Code 24BU3SEC07	Course Title Practicals Based on 24BU3SEC07	Credits (01)	No. of Lectures in hours 30
Practical 1	Identification of *S. aureus*-Gram staining, Isolation (SIBA, SMA), Biochemical profiling (phosphatase, Coagulase Test, Sugar Fermentations), rapid test (catalase)		
Practical 2	Identification of *E. coli*- Isolation (MacConkeys), Sugar Fermentations, IMViC		
Practical 3	Identification of *Pseudomonas spp*- Isolation (CLED), OF, oxidase, IMViC		
Practical 4	Selection and testing of antibiotics: Kirby-Bauer method		
Practical 5	Determination of MIC and MBC of an antibiotic		

Course Code: 24BU3VEC04	Course Title Environmental Biotechnology II	Credits (02)	No. of Lectures

COURSE OUTCOME

Students will be able to learn OR on completion of this course, students will be able to learn:

CO1	Define the concept of bioremediation and Environmental Impact Assessment (EIA)	L1
CO2	Explain the different types of bioremediations.	L2
CO3	Recall various renewable energy sources available and the current research in this field	L1
CO4	Explain air pollution and other global environmental problems.	L2

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	0	1	3	0	1
CO2	3	2	1	3	0	0
CO3	3	2	1	3	0	1
CO4	2	2	1	3	0	1

Units	Description	No. of lectures
Unit I: Role of Biotechnology in Environment Management	1.1 Bioremediation: a. Concept b. Bioremediation Strategies 1.2 Types: a. in situ (land farming, bioventing, biosparging, bioaugmentation) b. ex-situ (composting, biopile process, bioreactors) c. Gaseous bioremediation: Air pollution bioscrubbers and biofilters d. Bioremediation of contaminated ground water, oil spills e. Phytoremediation f. Metal bioremediation 1.3 EIA: a. Definitions and Purpose b. Basic steps of EIA c. EIA in India	**15**
Unit II: Renewable Energy	2.1 Renewable Energy Sources Overview of Solar, wind, hydro and geo power	**15**

Resources and Pollution	2.2 Biofuels: a. Types: solid, liquid b. Bioethanol and Biodiesel c. Microbial hydrogen gas production and use as a fuel d. Use of algae as a source of energy (*Botryococcus braunii*) 2.3 Biogas technology: Biogas plant and types Biogas production, composition, Applications 2.4 Pollution: Air pollution: Types, sources and classification of air pollutants and Soil and solid waste pollution 2.5 Global Environmental Problems: ENSO, Green House Effect, Acid rain, Ozone depletion, Global warming deforestation, biodiversity loss.	

Course Code 24BUBT3P03	Course Title Field Project in Biotechnology II	Credits (2)	No. of lectures-60

Course Outcomes

On completion of this course, students will be able to:

CO1	Apply basic academic and field-based skills to plan and execute a structured project or activity.	L3
CO2	Analyze information or data gathered during the activity to identify relevant patterns, issues, or insights.	L3
CO3	Interpret findings logically and connect them to the objectives of the project or activity.	L4
CO4	Communicate outcomes clearly through written reports, visual displays, or oral presentations.	L6

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	2	2	1
CO2	2	3	2	2	3	2
CO3	2	3	2	3	2	2
CO4	2	2	3	1	3	2

Description

The learner can take a field project as one of the options as CC for 2 credits. In this course, the learner can participate in activities that are based on biotechnology and help acquire field-based skills through planning and execution of activities of 60 Hrs. duration. The learner would be required to qualify the assessment where he / she would be required to communicate outcomes clearly, interpret findings logically through written reports, visual displays, or oral presentations.

Course Code 23BU3CC606	Course Title Departmental activities II	Credits 2	No. of lectures-60

Course Outcomes

On completion of this course, students will be able to:

CO1	Participate actively in academic, laboratory-based, outreach, or skill-oriented departmental activities.	L2
CO2	Demonstrate teamwork, time management, and organizational skills while performing assigned activities.	L3
CO3	Relate the experience gained from departmental activities to fundamental concepts of biotechnology and allied sciences.	L2
CO4	Communicate and reflect on learning experiences through presentations, reports, or creative academic outputs.	L6

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	2	1	3	2
CO2	2	1	1	1	3	2
CO3	3	2	2	2	2	2
CO4	2	1	3	1	3	3

Description

The learner can take departmental activity as one of the options as CC for 2 credits. In this course, the learner can participate in activities that are based on basic academics and help acquire field-based skills through planning and execution of activities of 60 Hrs. duration. The learner would be required to qualify the assessment where he / she would be required to communicate outcomes clearly, interpret findings logically through written reports, visual displays, or oral presentations.

Semester IV

Course Code: 24BUBT4T01	Course Title Biochemistry II	Credits (02)	No. of Lectures in hours

COURSE OUTCOME

Students will be able to learn OR on completion of this course, students will be able to learn:

CO1	Explain the classification of hormones and describe the structure, release, transport, functions, and disorders of hypothalamic, pituitary, thyroid and parathyroid hormones.	L2
CO2	Describe the structure, storage, release, transport, and functions of adrenal, pancreatic, and gonadal hormones, as well as their modes of action and role in regulating biological effects.	L3
CO3	Illustrate key carbohydrate metabolic pathways and their regulation, including glycolysis, the citric acid cycle, gluconeogenesis, the pentose phosphate pathway, the Cori cycle, and fermentation.	L2
CO4	Demonstrate understanding of respiration energy yield and protein metabolism, including amino acid reactions and the urea cycle.	L2

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	0	1	0	0	0
CO2	3	0	1	0	0	0
CO3	3	0	1	0	0	0
CO4	3	0	1	0	0	0

Units	Description	No. of lectures
Unit I: Endocrinology	1.1 Types of hormones based on: chemical nature, mechanism of action. 1.2 Structure, storage, release, transport, biochemical functions and disorders of: a. Hormones of hypothalamus- TRH, CRH, GnRH, GRH, GRIH, PRIH. b. Hormones of Anterior Pituitary Gland- GH, Stimulating hormones. c. Posterior Pituitary- Oxytocin and vasopressin. d. Thyroid gland- Thyroxine, Calcitonin. e. Parathyroid- PTH. f. Adrenal medulla- Epinephrine and Norepinephrine. g. Adrenal Cortex- Glucocorticoids, Mineralocorticoids. h. Pancreas- Insulin and glucagon. i. Female gonads (Estrogen and progesterone), Male gonads (testosterone), Placenta (hCG). 1.3 Introduction to hormone action and signal transduction of Group I and Group II hormones.	**15**

	1.4 Hormones can influence specific biologic effects by modulating transcription.	
Unit II: Carbohydrate and protein metabolism	2.1 Carbohydrate metabolism: a. Glycolytic Pathway (with structures) and its Regulation, b. Citric Acid Cycle (with structures) and its Regulation; c. Gluconeogenesis; Pentose Phosphate Pathway (with structures); d. Cori cycle; e. Homolactic Fermentation; Alcoholic Fermentation; f. Total energy yield during respiration (Calculation). 2.2 Protein metabolism: a. General reactions of amino acid metabolism (Oxidative deamination, Transamination, Decarboxylation). b. Glucogenic and ketogenic amino acids, Urea cycle (with structures).	**15**

Course Code: 24BUBT4T02	Course Title Immunology	Credits (02)	No. of Lectures in hours

COURSE OUTCOME

Students will be able to learn OR on completion of this course, students will be able to learn:

CO1	Explain the properties and types of antigen-antibody reactions, including principles of precipitation and agglutination techniques.	L2
CO2	Describe the principles and applications of advanced immunological techniques, including agglutination methods, complement fixation, RIA, ELISA, ELISPOT, Western blotting, immunofluorescence, and flow cytometry.	L2
CO3	Explain the significance of vaccines, types of immunization, various vaccine types, and the role of adjuvants.	L2
CO4	Describe new vaccine strategies, approaches for emerging diseases like HIV, COVID-19, and cancer, and the production and clinical use of monoclonal antibodies.	L2

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	0	1	0	0	0
CO2	3	0	1	0	0	0
CO3	3	3	0	0	3	2
CO4	3	3	0	0	3	2

Units	Description	No. of lectures
Unit I: Immunodiagnostics	1.1 Antigen-Antibody Reactions: Properties and types 1.2 Precipitation Reactions: Immunoprecipitation, Immuno-electrophoresis, CIEP, Rocket Electrophoresis and 2-D Immuno-electrophoresis. 1.3 Agglutination Reactions: Hemagglutination, Bacterial agglutination, Passive agglutination, Agglutination Inhibition 1.4 Complement Fixation Tests, RIA, ELISA, ELISPOT, Western Blot, Immunofluorescence, Flow Cytometry.	**15**
Unit II: Preventive Immunology	2.1 Vaccines: Introduction, significance 2.2 Active and passive immunization 2.3 Types of vaccines - Killed and attenuated vaccines, Whole organism vaccines, Purified macromolecules as vaccines, recombinant viral vector vaccines, DNA vaccines 2.4 Use of adjuvants in vaccine. 2.5 New vaccine strategies, Ideal vaccine	**15**

	2.6 Vaccine strategies for emerging infections/ illness: HIV, COVID 19, cancer 2.7 Monoclonal Antibodies 2.8 Production (Hybridoma technology), Clinical use	

Course Code: 24BUBT4T03	Course Title Molecular Techniques	Credits (02)	No. of Lectures in hours

COURSE OUTCOME

On completion of this course, students will be able to learn:

CO1	Explain the methods for extraction, isolation, and detection of DNA and RNA, along with the principles of chemical DNA synthesis.	L2
CO2	Describe the principle, components, design, and controls of PCR, including primer design, contamination issues, and product detection.	L2
CO3	Describe the principles of electrophoresis, types of gels and support media for protein separation, and techniques for protein detection, estimation, and recovery.	L2
CO4	Explain the principles and techniques of nucleic acid electrophoresis, including AGE, sequencing gels, PFGE, RNA electrophoresis, capillary, and microchip electrophoresis.	L2

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	1	0	0	0
CO2	3	1	1	0	0	0
CO3	3	1	1	0	0	0
CO4	3	1	1	0	0	0

Units	Description	No. of lectures
Unit I: Molecular Techniques -I	1.1 Extraction, Isolation and Detection of DNA (genomic and plasmid) & RNA. 1.2 Polymerase Chain Reaction: a. General Principle b. Components of a Typical PCR Reaction, Experimental design c. Primer Designing d. Control of PCR e. Contamination and Mis-priming f. PCR Product clean-up and detection 1.3 Chemical Synthesis of DNA	**15**
Unit II: Electrophoresis	2.1 General principles 2.2 Support media: Agarose and polyacrylamide 2.3 Electrophoresis of proteins a. SDS-PAGE b. Native Gels c. Gradient gels	**15**

	d. Isoelectric focusing gels e. 2D PAGE. f. Cellulose acetate electrophoresis g. Detection, estimation, recovery of proteins in gels. 2.4 Electrophoresis of nucleic acids: a. AGE of DNA (Rate of migration of DNA through agarose gels, classes of agarose and their properties, electrophoresis buffers, gel loading buffers, detection of DNA in agarose gels). b. DNA sequencing gels. c. PFGE (Types of apparatuses, factors affecting resolution). d. Electrophoresis of RNA 2.5 Capillary electrophoresis 2.6 Microchip electrophoresis	

Course Code: 24BUBT4P01	Course Title Practical based on 24BUBT4T01 and24BUBT4T02	Credits (02)	No. of Lectures in hours 60

COURSE OUTCOME

Students will be able to learn OR on completion of this course, students will be able to learn:

CO1	Analyze the results of liver function tests, LDH estimation to assess organ function and immunodiffusion techniques for assessing antigen-antibody interactions.	L4
CO2	Interpret the results of TLC, glucose estimation methods, amino acid breakdown assays, and Coomb's test to evaluate biochemical and diagnostic outcomes.	L4
CO3	Explain the principles, advantages, and limitations of protein estimation methods (Bradford, Biuret, Lowry) and the significance of assay parameters such as sensitivity, specificity, and accuracy in biomolecular analysis.	L2
CO4	Apply biochemical and immunological techniques—including ELISA, kidney function tests, and immunoelectrophoresis—to evaluate their effectiveness in clinical and diagnostic settings.	L3

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	1	0	2	0
CO2	3	1	1	0	2	0
CO3	3	1	1	0	0	0
CO4	3	1	1	0	0	0

Practical No.	Name of the experiment
Practical 1	Study of breakdown of amino acids – Lysine decarboxylase and deamination.
Practical 2	Estimation of biomolecules: Importance of sensitivity, specificity, accuracy while selecting assay
Practical 3	Protein estimation by Bradford method. Comparison with Biuret and Lowrys methods.
Practical 4	Estimation of glucose by GOD/POD method. Comparison with DNSA method.
Practical 5	Determination of Lactate Dehydrogenase (LDH) Activity in Blood Serum.
Practical 6	Organ Function Tests: Liver (SGPT, SGOT); Kidney (Urea from Serum)
Practical 7	TLC of sugars
Practical 8	SRID.
Practical 9	DID.
Practical 10	Coomb's Test.
Practical 11	Immunoelectrophoresis / Rocket Immunoelectrophoresis: demonstration
Practical 12	ELISA.

Course Code: 24BUBT4P02	Course Title Practical based on 24BUBT4T02 and 24BUBT4T03	Credits (02)	No. of Lectures in hours 60

COURSE OUTCOME

Students will be able to learn OR on completion of this course, students will be able to learn:

CO1	Analyze the separation of nucleic acids and proteins using agarose and polyacrylamide gel electrophoresis to evaluate molecular characteristics such as size, purity, and conformation.	L4
CO2	Analyze the steps involved in the preparation and sterility testing of TAB vaccine, including interpretation of test controls such as TC, NC, PC, and IC.	L4
CO3	Apply concepts of molarity, normality, and buffer chemistry to prepare accurate stock solutions and reagents for molecular biology experiments.	L2
CO4	Explain the principles behind vaccine preparation and sterility testing, buffer and reagent formulation, culture preservation methods, DNA extraction techniques, and electrophoresis of nucleic acids and proteins.	L3

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	1	0	2	0
CO2	3	1	1	0	2	0
CO3	3	1	1	1	0	0
CO4	3	1	1	1	1	0

Practical No.	Name of the experiment
Practical 1	Preparation of TAB Vaccine and sterility check.
Practical 2	Preparation of reagents for Molecular Biology Practicals: ● Concept of molarity, molality and normality, ● Preparation of acid of required normality - problem based learning ● Concept and importance of stock solution: Preparation of 1M Tris-Cl, pH 8.0; 0.5M EDTA, Tris equilibrated phenol pH 8.0 (Demonstration), 10% SDS, PBS, saline
Practical 3	● Buffers: Properties of ideal buffers ● Preparation of phosphate and acetate buffer
Practical 4	Preservation of recombinant cultures: maintenance on nutrient agar, lyophilization, preservation under liquid nitrogen.
Practical 5	Genomic DNA extraction
Practical 6	Plasmid DNA extraction
Practical 7	Separation of genomic and plasmid DNA by agarose gel electrophoresis
Practical 8	Polyacrylamide Gel Electrophoresis: native and SDS (demonstration)

Course Code: 24BUBT4T04	Course Title Fermentation Technology	Credits (02)	No. of Lectures in hours

COURSE OUTCOME

Students will be able to learn OR on completion of this course, students will be able to learn:

CO1	Summarise the principles and applications of foam separation, filtration, precipitation techniques, and methods used for cell disruption in downstream processing (DSP).	L2
CO2	Describe the different techniques used in DSP including centrifugation, chromatography, drying, crystallization, whole broth processing and membrane processes	L2
CO3	Explain the basic terminologies related to QA, GMP along with HACCP principles	L2
CO4	Discuss the various aspects of QA and QC	L2

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	0	0	0
CO2	3	2	1	0	0	0
CO3	3	1	1	0	0	1
CO4	3	1	1	0	0	1

Units	Description	No. of lectures
Unit I: Downstream processing	1.1 Introduction to DSP 1.2 Foam separation 1.3 Types of Precipitation 1.4 Filtration, Centrifugation, Chromatography in DSP 1.5 Cell disruption- physical and chemical methods 1.6 Solvent recovery, Membrane processes, Drying 1.7 Crystallization and Whole broth processing	**15**

Unit II: QA/ QC	2.1 Definitions: Manufacture, Quality, Quality control, concept of QC. 2.2 Concept of GMP and requirements of GMP implementation. Documentation and regulatory certification of GMP. 2.3 Variables of batch process. 2.4 QA and QC - Concept and requirements 2.5 QA and QC w.r.t- Raw materials, methods of manufacturing, in process items, finished products, labels and labelling and packaging materials. 2.6 Control of microbes during the manufacturing process. 2.7 Documentation and Regulation of QA and QC with example- FSSAI (regulatory agency). 2.8 Concept of HACCP with principles.	**15**

Course Code 24BUBT4T05	Course Title Population genetics and Cell-cell interactions	Credits (02)	No. of Lectures in hours

COURSE OUTCOME

Students will be able to learn OR on completion of this course, students will be able to learn:

CO1	Determine genotype frequency, allele frequency, genetic variation at DNA and protein level	L4
CO2	Explain Hardy-Weinberg law along with the concepts of Natural Selection, Genetic Drift, Speciation and role of population genetics in conservation biology	L2
CO3	Explain the composition and dynamic properties of the extracellular matrix and mechanisms of cell–matrix interactions.	L2
CO4	Describe and analyze the molecular basis of cell–cell adhesion and junctional complexes in maintaining tissue integrity and signalling	L1

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	0	0	0	0
CO2	3	0	0	1	0	1
CO3	3	0	1	0	0	0
CO4	3	0	1	0	0	0

Units	Description	No. of lectures
Unit I: Population genetics	1.1 Genetic Structure of Populations – Genotypic Frequencies and Allelic Frequencies 1.2 Hardy- Weinberg Law and its assumptions 1.3 Genetic Variations in Populations: Measuring Genetic Variation at Protein Level and measuring Genetic Variations at DNA level 1.4 Natural Selection, Genetic Drift, Speciation 1.5 Role of Population Genetics in Conservation Biology	**15**
Unit II: Cell-cell interactions	2.1 Extracellular space: ECM (Collagen, proteoglycans, fibronectin, laminin, dynamic properties) 2.2 Interaction of cells with extracellular materials: integrin, focal adhesions, hemidesmosomes 2.3 Interaction of cells with other cells: Selectins, IgSF, cadherins, Adherens junctions, desmosomes, role of cell associated receptors in transmembrane signalling 2.4 Tight junctions, Gap junctions, Plasmodesmata	**15**

Course Code: 24BU4AEC04	Course Title Employment communication and Entrepreneurship	Credits (02)	No. of Lectures in hours

COURSE OUTCOME

Students will be able to learn OR on completion of this course, students will be able to learn:

CO1	Plan a career based on personal potential and availability of opportunities	L3
CO2	Develop improved professional communication and interview skills	L3
CO3	Explain the concept of Entrepreneurship along with traits, Do's & Don'ts of a successful Entrepreneur	L2
CO4	Explain the Indian scenario with respect to biotechnology-based entrepreneurship and Intellectual property rights	L2

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	0	0	0	0	3
CO2	3	0	0	2	0	3
CO3	1	1	0	1	0	1
CO4	2	3	0	1	2	2

Units	Description	No. of lectures
Unit I: Employment communication	1.1 Process of career exploration a. Knowing yourself - personal characteristics b. Knowledge about the world of work, requirements of jobs including self-employment. c. Sources of career information d. Preparing for a career based on potentials and availability of opportunities 1.2 Professional communication a. Effective communication: Verbal, Non-Verbal, written and Cross-Cultural Communication, Transaction analysis b. Body Language; Listening Skills c. Formal vs. informal communication d. Barriers to effective communication e. Dress-code and You-attitude f. Cover Letter Writing g. Drafting formal mails h. Résumé Skills: Preparation and Presentation, Difference between a CV, Résumé, and Biodata, Essential Components of a Good Résumé, Common Errors 1.3 Interview Skills: Preparation and Presentation a. Types of Interviews	**15**

	b. STAR Approach for Facing an Interview c. Interview Procedure, Do's and Don'ts d. Important Questions Generally Asked in a Job Interview e. Interview Skills: Common Errors f. Interview Questions for Assessing Strengths and Weaknesses 1.4 Meaning, Importance and Types of Group Discussion a. Procedure of a Group Discussion b. Evaluation of Group Discussion c. Group Discussion: Common Errors	
Unit II: Entrepreneurship	2.1 Concept of Entrepreneur; Entrepreneurship, Traits of a Successful Entrepreneur, Do's & Don'ts of Entrepreneur 2.2 Nature of biotechnology Industry, concept of biotechnology park & Bioincubators 2.3 Entrepreneurship in Rural Areas: Indian scenario; Biotechnology based programmes for society by DBT 2.4 Licensing, Collaborations, Alliance, Mergers, Acquisition & Biopartnering for growth 2.5 Introduction to IPR, types of IP (patent, copyrights, geographical indications, trademarks, trade secret, Industrial designs) 2.6 Successful Entrepreneurs from India (Any 6 success stories from varied fields like Wine making, Mushroom cultivation, Hydroponics, Spirulina cultivation, Biocomposting, Bioinstrumentation etc)	**15**

Course Code: 24BU4SEC07	Course Title Digital Skills	Credits (01)	No. of Lectures in hours

COURSE OUTCOME

Students will be able to learn OR on completion of this course, students will be able to learn:

CO1	Explain the basic features of Microsoft Office, including its interface and applications, to effectively navigate and utilize its tools.	L2
CO2	Describe the features and benefits of Google apps	L2
CO3	Make use of MS-Word. MS-Excel, MS-Powerpoint	L3
CO4	Demonstrate proficiency in using Google apps for collaborative tasks and online productivity.	L3

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	3	0	0	0
CO2	1	1	3	0	0	0
CO3	1	1	3	0	0	0
CO4	1	1	3	0	0	0

Units	Description	No. of lectures
Unit I: Digital skills	1. Introduction to Microsoft Office 2. Finding your way around office interface 3. Microsoft office applications 4. Introduction to Google apps 5. Benefits of Google apps 6. Working with Google apps	**15**

Course Code 24BU4SEC07	Course Title Practicals Based on 24BU4SEC07	Credits (01)	No. of Lectures in hours 60
Practical 1	a. Basic details of Microsoft Office b. Working with the text		
Practical 2	Exploring MS office: a. MS Word a. MS Excel b. MS powerpoint		
Practical 3	Exploring Google Apps: a. Gmail a. Google drive b. Google calendar c. Google doc d. Google sheets e. Google slides f. Google meet		

Course Code 24BU4VEC01	Course Title Environmental Biotechnology III	Credits (02)	No. of Lectures in hours

COURSE OUTCOME

Students will be able to learn OR on completion of this course, students will be able to learn:

CO1	Explain the fundamental concepts of ecosystems	L2
CO2	Illustrate the nutrient cycles and types of interactions between organisms with examples	L2
CO3	Summarise features of various bioreactors used for industrial effluent treatment	L2
CO4	Explain the application of Biotechnology in industrial wastewater treatment	L2

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	0	1	1	0	0
CO2	3	0	1	1	0	0
CO3	3	1	1	1	0	0
CO4	3	1	1	1	0	0

Units	Description	No. of lectures
Unit I: Ecosystem & Interactions	Ecology and Biogeography: a. Ecosystems, Definition and Components b. Structure and Function of Ecosystems c. Aquatic and Terrestrial Ecosystems c. Biotic and Abiotic Factors d. Trophic Levels e. Food Chain and Food Web f. Ecological Pyramids (Energy, Biomass and Number) 1.2 Nutrient Cycle and Biogeochemical Cycles: Water, Carbon, Oxygen and Sulphur. 1.3 Interactions: Commensalism, Mutualism, Predation and Antibiosis, Parasitism.	**15**
Unit II: Industrial water treatment	1. Biological processes for industrial effluent treatment: Aerobic biological treatment- activated sludge process, CASP, advanced activated sludge processes (Nitrogen and Phosphorous removal), Solid waste treatment 2. Biological filters, RBC, FBR Anaerobic biological treatment- contact digesters, packed bed reactors, anaerobic baffled digesters, UASB 3. Pollution indicators & biosensors 4. Biodegradation of xenobiotics- persistent compounds, chemical properties influencing biodegradability, microorganisms in biodegradation	**15**

	5. Use of immobilized enzymes or microbial cells for treatment; 6. Packaged organisms and genetically engineered organisms in waste treatment	

Course Code 24BUBT4P03	Course Title Field Project in Biotechnology III	Credits (02)	No. of lectures-60

Course Outcomes

On completion of this course, students will be able to:

CO1	Apply basic academic and field-based skills to plan and execute a structured project or activity.	L3
CO2	Analyze information or data gathered during the activity to identify relevant patterns, issues, or insights.	L3
CO3	Interpret findings logically and connect them to the objectives of the project or activity.	L4
CO4	Communicate outcomes clearly through written reports, visual displays, or oral presentations.	L6

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	2	2	1
CO2	2	3	2	2	3	2
CO3	2	3	2	3	2	2
CO4	2	2	3	1	3	2

Description

The learner can take a field project as one of the options as CC for 2 credits. In this course, the learner can participate in activities that are based on biotechnology and help acquire field-based skills through planning and execution of activities of 60 Hrs. duration. The learner would be required to qualify the assessment where he / she would be required to communicate outcomes clearly, interpret findings logically through written reports, visual displays, or oral presentations.

Course Code 23BU4CC606	Course Title Departmental activities III	Credits (02)	No. of lectures-60

Course Outcomes

On completion of this course, students will be able to:

CO1	Participate actively in academic, laboratory-based, outreach, or skill-oriented departmental activities.	L2
CO2	Demonstrate teamwork, time management, and organizational skills while performing assigned activities.	L3
CO3	Relate the experience gained from departmental activities to fundamental concepts of biotechnology and allied sciences.	L2
CO4	Communicate and reflect on learning experiences through presentations, reports, or creative academic outputs.	L6

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	2	1	3	2
CO2	2	1	1	1	3	2
CO3	3	2	2	2	2	2
CO4	2	1	3	1	3	3

Description

The learner can take departmental activity as one of the options as CC for 2 credits. In this course, the learner can participate in activities that are based on basic academics and help acquire field-based skills through planning and execution of activities of 60 Hrs. duration. The learner would be required to qualify the assessment where he / she would be required to communicate outcomes clearly, interpret findings logically through written reports, visual displays, or oral presentations.

REFERENCES

Semester III

Major - Biochemistry I

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Lehninger, principles of biochemistry	David Nelson and Michael Cox	*W.H. Freeman* and Company, New York.	4th	2005
2.	Illustrated Biochemistry	Harper	Lange Medical Books/McGraw-Hill	26th	2003
3.	Prescott, Harley & Klein's Microbiology	Willey, Sherwood and Woolverton	McGrawHill	7th	2008
4.	Molecular biology of the cell	Bruce Alberts	Garland Science	4th	2002
5.	Lehninger, principles of biochemistry	David Nelson and Michael Cox	WH Freeman & Co	5th	2008
6.	Outlines of Biochemistry	Conn, E.E., P. K.Stumpf, G. Bruening and R. Y.	John Wiley &Sons. New York.	5th	1987
7.	Biochemistry	Satyanarayana and Chakrapani	Books & Allied (P) Ltd	4th	2017

Major - Biophysics

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.5	Nature and Properties of Light	Linda J. Vandergriff	PDF	-	-
1.6	The Laser Technology: New Trends in Biology and Medicine	Luc G. Legres, Christophe Chamot, Mariana Varna, Anne Janin	PDF	-	-
1.7	A Textbook of Optics	Dr. N Subrahmanyam	S. Chand	25th	2012
1.8	Principles of Fermentation Technology	Peter F. Stanbury Allan Whitaker Stephen J. Hall	Elsevier	3rd	2017
1.9	Biophysical Chemistry Principles and Techniques	Upadhyay, Upadhyay and Nath	Himalaya	Revised	2009
1.10	Principles and techniques of Biochemistry and Molecular Biology	Wilson and Walkar	Cambridge University Press	7th	2010
1.11	Chapter 10: Mechanical properties of fluid	NCERT	-	-	-

	Chapter 5: Magnetism and Matter				
1.12	Oscillations, Waves and Acoustics	P. K. Mittal	I. K. International Pvt Ltd	-	2010
1.13	Principle and techniques of Biochemistry and Molecular Biology	Wilson and Walker	Cambridge University Pass	7th	2010
1.14	Molecular cloning: A lab manual	Sambrook and Russell	Cold Spring Harbor Laboratory Pass	3rd	2001

Major: Tissue culture

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Plant tissue Culture	Kalyan Kumar De	New Central Book Agency		2008
2.	Introduction to Plant tissue Culture	M.K. Razdan	Oxford and IBH Publishing	2nd	2019
3.	Principle and Practice of Animal Tissue Culture	Sudha Gangal	Universities Press	2nd	2010

Minor – Medical Microbiology

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Prescott, Harley and Klein's Microbiology	Willey, Sherwood, Woolverton	McGraw-Hill International edition	7th	2008
2.	Prescott, Harley and Klein's Microbiology	Willey, Sherwood, Woolverton	McGraw-Hill International edition	5th	2002
3.	Microbiology, An Introduction	Tortora, Funke & Case	Pearson education	10th	2010
4.	Foundations in Microbiology	Kathleen Park Talaro	McGraw-Hill International edition	8th	2012
5.	Jawetz, Melnick and Adelberg's Medical Microbiology	G.F. Brooks, Morse, Carroll, Mietzner, Butel	Lange publication	26th	2013
6.	Ananthanarayan and Paniker's Textbook of Microbiology	Reba Kanungo	Universities Press	10th	-

7.	Mim's Medical Microbiology	Goering, Mark Zuckerman, Dockrell, Chiodini	Elsevier Limited	6th	2019

Generic - Molecular Biology

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	iGenetics: A Molecular Approach	Peter Russell	Pearson Education	3rd	2009
2.	Lehninger, principles of biochemistry	David Nelson and Michael Cox	W.H. Freeman and Company, New York.	4th	2005

AEC - Research Methodology

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Research Methodology	C R Kothari	New Age International Publishers	2nd Revised Edition	2004
2.	Research Methodology in the Medical and Biological Sciences	Laake, Benestad & Olsen	Academic Press, Elsevier	2nd Edition	2007
3.	Introduction to Research Methodology	Imre Boncz	University of Pece	1st Edition	2015
4.	Research Methodology: A step-by-step guide to beginners	Ranjit Kumar	Sage Publication	5th Edition	2019
5.	https://www.scholarify.in/application-of-ict-in-research/	-	-	-	-

SEC – Microbial Diseases & Conventional Laboratory Diagnosis

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Foundations in Microbiology	Kathleen Park Talaro	McGraw-Hill International edition	8th	2012
2.	Jawetz, Melnick and Adelberg's Medical Microbiology	G.F. Brooks, Morse, Carroll, Mietzner, Butel	Lange publication	26th	2013
3.	Ananthanarayan and Paniker's Textbook of Microbiology	Reba Kanungo	Universities Press	10th	-

4.	Mim's Medical Microbiology	Goering, Mark Zuckerman, Dockrell, Chiodini	Elsevier Limited	6th	2019

VEC - Environmental Biotechnology

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Environmental Microbiology	Maier, Pepper & Gerba	Academic Press by Elsevier	2nd	2009
2.	Environmental Biotechnology	M H Fulekar	Science Publishers	1st	2010
3.	Environmental Biotechnology	Indu Shekhar Thakur	Dreamtech Press	2nd	2019
4.	Environmental Biotechnology	Alan Scragg	Oxford Press	2nd	2005

Semester IV

Major - Biochemistry II

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Illustrated Biochemistry	Harper	Lange Medical Books/McGraw-Hill	26th	2003
2.	Lehninger, principles of biochemistry	David Nelson and Michael Cox	*W.H. Freeman* and Company, New York.	4th	2005
3.	Fundamentals of Biochemistry	D. Voet and J. Voet	Wiley plus	5th	2011
4.	Biochemistry	Satyanarayana and Chakrapani	Books & Allied (P) Ltd	4th	2017
5.	The Physiology and Biochemistry of Prokaryotes	White, D.	Oxford University Press	3rd	1995

Major: Immunology:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Immunology	Kuby	W.H. Freeman	6th	2006
2.	Immunology: essential and Fundamental	Palan and Pathak	Science Publishers	2nd	2005
3.	The Elements of Immunology	Fahim Khan	Pearson Education	-	2009

Major: Molecular Techniques

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Molecular cloning: A lab manual	Sambrook and Russell	Cold Spring Harbor Laboratory Pass	3rd	2001
2.	Molecular Diagnostics: Fundamentals, Methods and Clinical Applications	Lela Buckingham and Maribeth L Flaws	F.A. Davis Company	-	2007

Minor: Fermentation Technology

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Industrial Microbiology	L.E Casida, Jr	New Age International Publishers	2nd	2019

2.	Principles of Fermentation Technology	P.F. Stanbury, A. Whitaker, S.J. Hall	Butterworth Heinemann, oxford	2nd	2000
3.	Industrial Microbiology	A.H Patel	Macmillan	1st	1984

Generic - Population Genetics and Cell-cell interactions

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Genetics: A Conceptual Approach	Benjamin A. Pierce	WH Freeman	3rd	2007
2.	Prescott, Harley & Klein's Microbiology	Willey, Sherwood & Woolverton	McGraw-Hill	7th	2008
3.	Cell Biology	Gerald Karp	John Wiley	6th	2010

AEC: Communication Skills

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	NCERT source https://archive.nptel.ac.in/courses/109/105/109105144/	Dr. Seema Singh	NCERT	-	-
2.	Effective workplace communication: skills for success in life and on the job	Ludden, Marsha	Indianapolis, Ind.: JIST Works	-	2007
3.	Advanced professional communications: Chapter 8 Introduction to employment communication (Chapter 8: Introduction to Employment Communication – Advanced Professional Communication (pressbooks.pub))	Open library	(Powered by Pressbooks)		Copyright 2021
4.	Unit 12 Communication for Employment (IGNOU self-learning material) Unit 12.pdf (egyankosh.ac.in)	Neeti Agrawal	IGNOU	-	2012
5.	Employability skills (NSQF)	-	National instructional media institute	1st	2018
6.	Curriculum and Guidelines for Life Skills (Jeevan Kaushal) 2.0	-	University Grants Commission	-	2023

8.	Entrepreneurship & Business of Biotechnology	S N Jogdand	Himalaya publishing house	1st Edition	2007
9.	Entrepreneurship	Kurup	-	-	-
10.	Handbook of Entrepreneurship development	Basotia and Sharma	Mangaldeep publication	1st Edition	-
11.	The Entrepreneur's guide to a Biotech Start-up	Peter Kolchinsky	www.evelexa.com	4th edition	-Ne
12.	Entrepreneurship Ideas in Action	Cynthia Greene	South Western Educational Publishing	2nd Edition	-

SEC - Digital skills

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Office 2019 All-in-One For Dummies	Peter Weverka	Wiley	-	2018
2.	Microsoft Office 2019 Step by Step	Joan Lambert, Curtis Frye	Pearson Education	-	2018
3.	My Google Apps	Patrice-Anne Rutledge, Sherry Kinkoph Gunter	Pearson Education	-	2015

VEC: Environmental Biotechnology

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Cell Biology, genetic, Molecular Biology, Evolution and Ecology	Verma &Agarwal	S Chand	1st	2004
2.	Prescott, Harley & Klein's Microbiology	Willey, Sherwood and Woolverton	McGrawHIll	7th	2008
3.	Environmental Microbiology	Maier, Pepper & Gerba	Academic Press by Elsevier	2nd	2009
4.	Environmental Biotechnology	M H Fulekar	Science Publishers	1st	2010
5.	Environmental Biotechnology	Indu Shekhar Thakur	Dreamtech Press	2nd	2019
6.	Environmental Biotechnology	Alan Scragg	Oxford Press	2nd	2005

VPM's B.N. Bandodkar College of Science (Autonomous), Thane
Curriculum Structure for the Undergraduate Degree Programme S.Y.B.Sc Biotechnology

	SEMESTER – III	Course imparts Employability (EM), Entrepreneurship (EN), Skill Development (SD)			Course integrates with Professional Ethics (PE), Gender Equity (GE), Human Value (HV), Environmental Sustainability (ES)			
Course Code	**Major Course Title**	**EM**	**EN**	**SD**	**PE**	**GE**	**HV**	**ES**
24BUBT3T01	Biochemistry I	-	-	-	-	-	-	-
24BUBT3T02	Fundamentals of Biophysics	-	-	-	-	-	-	-
24BUBT3T03	Plant and Animal Tissue Culture	-	-	-	-	-	-	-
24BUBT3P01	Practical based on 24BUBT3T01 and 24BUBT3T02	✔	-	✔	✔	-	-	✔
24BUBT3P02	Practical based on 24BUBT3T02 and 24BUBT3T03	✔	-	✔	✔	-	-	✔
24BU3SEC07	Microbial Diseases & Conventional Laboratory Diagnosis	-	-	✔	-	-	-	-
24BUBT3T04	Infectious Diseases and Chemotherapy	-	-	✔	-	-	-	-
24BUBT3T05	Molecular Biology I	✔	-	✔	✔	-	-	-
24BU3AEC04	Research Methodology	-	-	-	-	-	-	-
24BU3VEC04	Environmental Biotechnology II	-	-	✔	✔	-	✔	✔
24BUBT3P03	Field Project in Biotechnology II	-	-	✔	✔	-	✔	✔
23BU3CC606	Departmental Activities II	-	-	✔	✔	-	✔	✔

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	SEMESTER – IV	Course imparts Employability (EM), Entrepreneurship (EN), Skill Development (SD)			Course integrates with Professional Ethics (PE), Gender Equity (GE), Human Value (HV), Environmental Sustainability (ES)			
Course Code	**Major Course Title**	**EM**	**EN**	**SD**	**PE**	**GE**	**HV**	**ES**
24BUBT4T01	Biochemistry II	-	-	-	-	-	-	-
24BUBT4T02	Immunology	-	-	-	-	-	-	-
24BUBT4T03	Molecular Techniques	-	-	✔	-	-	-	-
24BUBT4P01	Practical based on 24BUBT4T01 and 24BUBT4T02	✔	-	✔	✔	-	-	✔
24BUBT4P02	Practical based on 24BUBT4T02 and 24BUBT4T03	✔	-	✔	✔	-	-	✔
24BUBT4T04	Fermentation Technology	-	-	✔	-	-	-	-
24BU4SEC07	Digital Skills	✔	✔	✔	-	-	-	-
24BUBT4T05	Population Genetics and Cell-cell interactions	-	-	✔	-	-	-	-
24BU4AEC04	Employment communication and Entrepreneurship	✔	✔	✔	✔	✔	✔	-
24BU4VEC01	Environmental Biotechnology III	-	-	-	-	-	-	✔
24BUBT4P03	Field Project in Biotechnology III	-	-	✔	✔	-	✔	✔
23BU4CC606	Departmental Activities III	-	-	✔	✔	-	✔	✔