Academic Council Meeting No. and Date: 9 / July 02, 2024

Agenda Number:3 Resolution Number: 41, 42/3.9, 3.29

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

Syllabus for

Programme Code : BUMB
Programme: Bachelor of Science

Specific Programme: Microbiology

[S.Y.B.Sc. Microbiology]
Level 5.0

CHOICE-BASED GRADING SYSTEM

Revised under NEP and Autonomy

From academic year 2024 - 2025

Preamble

Under-graduate (UG) program in Microbiology offers opportunities for students to learn fundamental microbiology, biochemistry, immunology, genetics, molecular biology and their applications in various industries like food, agriculture, dairy, health care etc. With the goal of engaging the learners in learning basic concepts in microbiology and acquaint them with current developments in the field that can be correlated better with theoretical learning, the syllabus was re-framed under autonomy. Continuing the Choice Based Credit System (CBCS) implemented by the esteemed University of Mumbai from the academic year 2016-2017, the existing syllabus of S.Y.B.Sc. Microbiology is restructured according to the NEP reforms for its effective implementation from 2024-25 under the autonomous status of VPM's B. N. Bandodkar College of Science.

With Microbiology (major) and vocational skill enhancement courses, In semester III and IV, learners would be introduced to molecular biology, biochemistry, immunology, clinical microbiology and environmental microbiology. They would develop practical skills and know the basics of microbial diagnostics.

In addition to these, in each semester, the student would be required to undertake 60 hours each of a field project to get experiential learning; and a Co-curricular course (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. Kalpita Mulye
Chairperson, BOS Microbiology
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 socially aware citizens. Build an attitude of unbiased, truthful actions and avoid unethical behaviour in all aspects of life.

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

Discipline/Subject: **MICROBIOLOGY**

Program Specific Outcome

1	Recall and define fundamental concepts related to microorganisms, including their diversity, structure, physiology, genetics, and ecological interactions.	L1
2	Explain the principles underlying microbiological, biochemical, immunological, and molecular biology techniques used in laboratory investigations, with emphasis on biosafety and scientific practices.	L2
3	Apply microbial principles to industrial, clinical, agricultural, and environmental contexts, and demonstrate how microorganisms are utilized in various biotechnological processes.	L3
4	Analyze and interpret microbiological data related to health and disease, including basic diagnostic, immunological, and antimicrobial concepts in clinical microbiology.	L4
5	Evaluate microbiological problems using critical thinking, data interpretation, and experimental reasoning to propose evidence-based and scientifically sound solutions.	L5
6	Design and propose microbiology-based approaches to address societal and environmental challenges, emphasizing sustainability, public health, and community welfare.	L6

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

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Curriculum Structure for the Undergraduate degree
S.Y.B.Sc. (Microbiology)

Semester III				
	Course Code	**Course Title**	**No. of lectures In hrs.**	**Credits**
Major	24BUMB3T01	Environmental Microbiology	30	2
	24BUMB3T02	Microbial Physiology and Protein Analytics	30	2
	24BUMB3T03	Bioprocess Technology and Food Microbiology	30	2
	24BUMB3P01	Practicals Based on 24BUMB3T01 and 24BUMB3T02	60	2
	24BUMB3P02	Practicals Based on 24BUMB3T02 and 24BUMB3T03	60	2
SEC	24BU3SEC05	Electrophoresis and Centrifugation	45	2
Generic	24BUMB3T05	Environmental Influence and Control of Microbes	30	2
AEC	24BU3AEC02	Research Methodology and Professional Communication	30	2
FP	24BUMB3P03	Field Project in Microbiology I	60	2
CC	23BU3CC606	Departmental activities II	60	2

Semester IV				
	Course Code	**Course Title**	**No. of lectures In hrs.**	**Credits**
Major	24BUMB4T01	Replication and Transcription	30	2
	24BUMB4T02	Biochemistry	30	2
	24BUMB4T03	Infection and Immunology	30	2
	24BUMB4P01	Practicals Based on 24BUMB4T01 and 24BUMB4T02	60	2
	24BUMB4P02	Practicals Based on 24BUMB4T02 and 24BUMB4T03	60	2
SEC	24BU4SEC05	Clinical Microbiology	45	2
Generic	24BUMB4T05	Food Microbiology	30	2
AEC	24BU4AEC02	Basic Bioinformatics and Biostatistics	30	2
FP	24BUMB4P03	Field Project in Microbiology II	60	2
CC	23BU4CC606	Departmental activities III	60	2

Semester III

Course Code 24BUMB3T01	Course Title Environmental Microbiology	Credits (02)	No. of lectures in hours 30

COURSE OUTCOME

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

CO1	Relate microbial survival in air and its sampling methods, airborne pathogen, and aerosol control	L1
CO2	Explain methods to study soil microbes, composition and types of soils, and biogeochemical cycles	L2
CO3	Apply basic concepts of freshwater microbiology, water borne infections, index organisms, bacteriological analysis of potable water	L3
CO4	Compare different aspects of waste water analysis, industrial pollutants , its health hazards and sewage treatment methods	L4

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	3	0	1
CO2	3	1	1	3	0	1
CO3	3	1	1	2	0	1
CO4	3	1	1	2	1	1

Units	Description	No of lectures
Unit 1: Air & Soil Microbiology	**1.1 Air microbiology** a. Important Airborne Pathogens and Important Toxins released by Airborne bacteria b. Aerosols, Nature of Bioaerosols, Aeromicrobiological pathway c. Microbial survival in the air d. Extramural and Intramural aeromicrobiology (Overview) e. Bioaerosol Control f. Air sampling methods and devices **1.2 Soil Microbiology** a. Composition and types of soil, textural triangle b. Types of soil microorganisms and their activities c. Methods of studying soil microorganisms: Sampling, Cultural methods, Physiological methods, d. Immunological methods, Nucleic acid based methods, Radioisotope techniques e. Biogeochemical cycles: Carbon, Nitrogen, Phosphorus, Sulfur Soil Microbiome (Introduction)	**15**
Unit 2: Fresh water & Sewage Microbiology	**2.1 Freshwater Microbiology** a. Freshwater environments and microorganisms found in Springs, rivers and streams, Lakes, marshes and bogs and marine environment b. Potable water definition, Purification of raw water	**15**

	c. Bacteriological standards of potable water Maharashtra pollution control board (MPCB), Central pollution control board (CPCB), Bureau of Indian standards (BIS) World health Organization (WHO) d. Water borne Infections e. Index organisms: Indicators of fecal pollution f. Bacteriological analysis of water for potability: Presumptive (Multiple tube fermentation- MPN), Confirmed, Completed) **2.2 Wastewater Microbiology** a. Waste water analysis: Physico-chemical parameters: pH, temperature, TS, COD, BOD, Toxicity b. Industrial water pollutants c. Ecological effects (Biomagnification and Eutrophication) and health hazards d. Removal of Pathogens by Sewage Treatment Processes, Oxidation Ponds and Septic tanks, Sludge Processing, Disposal of treated wastewater and biosolids	

Course Code 24BUMB3T02	Course Title Microbial physiology and protein analytics	Credits (02)	No. of lectures in hours 30

COURSE OUTCOME

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

CO1	Summarise composition of cell membrane and methods to study solute transport along with passive transport system	L2
CO2	Outline the active transport, co-transport systems and uptake of various molecules	L2
CO3	Elaborate on protein structures, types, purification methods and assays	L6
CO4	Compare different chromatographic techniques for protein separation	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	0	1	0	0	0
CO2	3	0	1	0	0	0
CO3	3	1	0	0	1	0
CO4	3	2	0	0	3	0

Units	Description	No of lectures
Unit 1: Biological Membrane transport	1.1 Composition and architecture of membrane a. Lipids and properties of phospholipid membranes b. Integral & peripheral proteins c. Aquaporins d. Mechanosensitive channels 1.2 Methods of studying solute transport a. Use of whole cell b. Liposomes c. Proteoliposomes 1.3 Solute transport across membrane a. Passive transport and facilitated diffusion by membrane proteins b. Co-transport across plasma membrane - (Uniport, Antiport, Symport) c. Active transport & electrochemical gradient d. Ion gradient provides energy for secondary active transport e. Lactose transport f. ATPases and transport (only Na-K ATPase) g. Shock sensitive system – Role of binding proteins h. Maltose uptake (Diagram and description) i. Histidine uptake (Diagram and description) j. Phosphotransferase system k. Schematic representation of various membrane transport systems in bacteria	**15**
Unit 2:	2. 1. Protein structure : overview 2.2. Types of proteins and examples	**15**

Protein analysis and purification	2.3. Purification of protein: a. Recognizing protein of interest b. Criteria for protein purification: Solubility, size, charge, binding affinity 2.4. Protein assays 2.5. Techniques of protein purification: protein precipitation, Salting in salting out, crystallization 2.6. Chromatographic techniques for protein separation a. Adsorption chromatography b. Gas liquid chromatography c. gel permeation chromatography d. Ion exchange chromatography e. Affinity chromatography f. High performance liquid chromatography	

Course Code 24BUMB3T03	Course Title Bioprocess Technology and Food Microbiology	Credits (02)	No. of lectures in hours 30

COURSE OUTCOME

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

CO1	Recall different components of basic fermenter with their functional significance, types of fermenters and their purpose, fermenter media design	L1
CO2	Apply methods of screening and strain improvement for isolating specific organisms	L2
CO3	Explain microbial growth and food spoilage, and its Control	L4
CO4	Distinguish different methods of food preservation, food control enforcements, food borne illnesses	L4

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	1	0	0
CO2	3	2	1	1	0	1
CO3	3	1	1	2	0	1
CO4	3	1	1	1	0	1

Units	Description	No of lectures
Unit 1: Introduction to Bioprocess Technology	1.1 An introduction to fermentation processes, The range of fermentation processes 1.2 Basic design of a fermenter, sensor, and its types 1.3 Various types of fermenters and their purpose 1.4 Types of fermentations: Surface and Submerged; Batch and Continuous, Aerobic and anaerobic 1.5 Screening methods: Primary and secondary screening High throughput screening methods 1.6 Strain improvement: selection of induced mutants synthesizing improved levels of primary metabolites; 1.7 Basic components of fermentation medium	**15**
Unit 2: Food Microbiology	2.1 Microbes as food, overview of fermented foods 2.2 Microbial growth and food spoilage 2.3 Controlling food spoilage: a. Homeostasis and hurdle technology b. Naturally occurring antimicrobials: lysozyme, lactoferrin and other Fe binding proteins, avidin, spices and essential oils, onions and garlic, isothiocyanates, phenolic compounds c. Antimicrobial chemicals: organic acids, nitrites, Para-benzoic acid, sodium chloride, phosphates, sulfites d. Biopreservation: controlled acidification, bacteriocins probiotics, prebiotics and synbiotics	**15**

	e. Physical methods of food preservation: drying, freeze-drying, cold storage, heat treatment: concept of TDP and TDT f. Preservation by irradiation: UV and ionizing radiations g. Food Control Enforcement & Control Agency: International agencies, Federal agencies (FDA, USDA), FSSAI [website], Introduction to HACCP h. Important Microorganisms in Food Microbiology: Spoilage causing microorganisms, Food-borne Illness associated Microorganisms	

Course Code 24BUMB3P01	Course Title Practicals Based on 24BUMB3T01 and 24BUMB3T02	Credits (02)	No. of lectures in hours 60
COURSE OUTCOME			
On completion of this course, students will be able to learn:			
CO1	Apply isolation and enrichment techniques for variety of organisms from soil microflora		L3
CO2	Enumerate bacterial load of a confined space using gravity sedimentation method		L6
CO3	Analyze water samples for potability		L4
CO4	Apply the methods of water testing for understanding efficiency of water treatment processes		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	2	3	0	3	3	0
CO2	2	3	0	3	3	1
CO3	2	3	0	1	3	1
CO4	2	3	0	3	3	3

Practical no.	Name of the experiment
Practical 1	Protein precipitation using ammonium sulfate
Practical 2	Desalting using dialysis method
Practical 3	Ion exchange Chromatography (Demo)
Practical 4	Gel permeation Chromatography (Demo)
Practical 5	Estimation of proteins using Folin Lowry's method
Practical 6	Production of amylase by solid state and submerged fermentation
Practical 7	Study of Classic fermentation
Practical 8	Primary screening by Crowded plate and Wilkin's agar overlay method
Practical 9	Isolation of organisms causing Food Spoilage
Practical 10	Determination of MIC of salt, sugar, chemical preservative
Practical 11	Determination of TDP
Practical 12	Determination of TDT

Course Code 24BUMB3P02	Course Title Practicals Based on 24BUMB3T02 and 24BUMB3T03	Credits (02)	No. of lectures in hours 60
COURSE OUTCOME			
On completion of this course, students will be able to learn:			

CO1	Apply the procedures of protein purification	L3
CO2	Estimate concentration of protein in unknown sample using Lowry's method	L6
CO3	Apply primary screening methods to isolate desired organism and utilise it for lab scale fermentation process	L3
CO4	Determine the MIC, TDP TDT of an isolate from spoiled food	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	2	3	0	0	3	0
CO2	2	3	0	0	3	0
CO3	2	3	0	1	3	0
CO4	2	3	0	1	3	1

Practical no.	Name of the experiment
Practical 1	Gravity sedimentation method for Air microflora analysis
Practical 2	Determination of Soil pH and Soil moisture content
Practical 3	Enrichment and isolation of microorganisms from soil: Nitrifying bacteria (in liquid medium) qualitative detection
Practical 4	Enrichment and isolation of microorganisms from soil: Ureolytic bacteria (Broth and Agar)
Practical 5	Enrichment and isolation of microorganisms from soil: Cellulolytic bacteria (liquid medium qualitative detection) and isolation
Practical 6	Isolation of Phosphate solubilizing bacteria
Practical 7	Winogradsky's column
Practical 8	Routine analysis of water (SPC)
Practical 9	Detection of Coliforms in water: Presumptive Test, Confirmed Test and Completed Test
Practical 10	Rapid Detection of *E.coli* by MUG Technique
Practical 11	Study of microbial flora in raw and treated sewage
Practical 12	Determination of BOD of waste water
Practical 13	Determination of COD of waste water

Course Code 24BU3SEC05	Course Title Electrophoresis and Centrifugation	Credits (01)	No. of lectures in hours 15

COURSE OUTCOME

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

CO1	Explain basic principles of electrophoresis and centrifugation methods	L2
CO2	Perform AGE and PAGE	L3
CO3	Apply centrifugation techniques to separate blood components	L3
CO4	Demonstrate the isolation of mitochondria using differential centrifugation	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	2	1	0	1	2	0
CO2	3	2	0	1	2	1
CO3	3	2	0	1	2	1
CO4	3	2	0	0	2	0

Units	Description	No of lectures
Unit 1: Electrophoresis and Centrifugation	**1.1 Electrophoresis:** General principles a. Support media: Agarose and polyacrylamide b. Electrophoresis of proteins: SDS-PAGE & Native Gels c. Detection, estimation, recovery of proteins in gels d. 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) **1.2 Centrifuge:** Basic principles of sedimentation: RCF and sedimentation concepts, Sedimentation rate or velocity, Sedimentation equilibrium, Svedberg unit a. Types of centrifuges b. Types of rotors c. Preparative centrifugation: i. Differential centrifugation ii. Density gradient centrifugation d. Analytical centrifugation: Ultracentrifuge	**15**

Course Code	Course Title Practicals based on 24BU3SEC05	Credits (01)	No. of lectures. 30 hr

Practical No.	Name of the experiment
Practical 1	Introduction to electrophoresis apparatus (Horizontal & vertical)
Practical 2	Agarose gel electrophoresis
Practical 3	Polyacrylamide gel electrophoresis
Practical 4	Isolation of mitochondria using differential centrifugation
Practical 5	Separation of blood components using ficoll-Hypaque gradient centrifugation

Course Code 24BUMB3T05	Course Title Environmental Influence and Control of Microbes	Credits (02)	No. of lectures in hours 30

COURSE OUTCOME

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

CO1	Elaborate on the various environmental factors that influence microbial growth	L6
CO2	Explain the effect of human influence on microbial ecosystem	L2
CO3	Apply the physical, chemical and biological agents to control the microbial growth	L3
CO4	Relate with the day to day examples of antimicrobial agents used	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	0	2	0	0
CO2	3	1	0	2	0	0
CO3	3	1	1	1	0	1
CO4	3	0	1	0	0	1

Units	Description	No of lectures
Unit 1: Environmental Influences	1.1 Environmental Limits on Growth 1.2 Temperature & Pressure a. Growth rate & temperature b. Classification of microorganisms by growth temperature c. The Heat Shock Response d. Adaptation to pressure 1.3 Osmolarity : Osmotic stress and protection against it 1.4 pH & hydroxide ion concentration 1.5 Oxygen : benefits & risks of Oxygen, Aerobes, anaerobes & facultative anaerobes 1.6 Nutrient deprivation & starvation 1.7 Human Influence on microbial ecosystem	**15**
Unit 2:	Physical agents that inhibit or kill the organisms 2.1. temperature & pressure	**15**

Microbial Control	2.2. filtration 2.3. Irradiation 2.4. Story of *Deinococcus* Chemical agents that kill microbes 2.5. factors that influence the efficacy of chemical agent 2.6. The Phenol coefficient 2.7. Commercial disinfectants 2.8. antimicrobial touch surfaces 2.9. Bacteria resistant to disinfectants 2.10. Antibiotics 2.11. Biological control of microbes	

Course Code 24BU3AEC02	Course Title Ability Enhancement Course: Research Methodology and Professional Communication	Credits (02)	No. of lectures in hours 15

COURSE OUTCOME

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

CO1	Understand and explain the fundamental principles of research methodology including research design, literature review, data collection	L4
CO2	Apply ethical principles,explain concepts of report writing and technological tools in conducting and presenting research, including plagiarism checks, grant writing, and use of digital research platforms.	L1
CO3	Describe the types of professional communication	L2
CO4	Prepare resume of oneself for job applications	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	2	0	0	3	1
CO2	3	3	1	0	3	2
CO3	3	2	2	0	3	2
CO4	3	1	3	0	3	3

Units	Description	No of lectures
Unit 1: Research Methodology	a. Criteria of Good Research, Problems encountered by researchers in India, Selecting the problem b. Research Design: Features of a good design c. Importance of Literature Review in research, Writing a review article d. Types of data: primary & secondary, methods of data collection e. Significance of Report writing, Layout of research report f. Scientific conduct and misconduct, Plagiarism, Punishment of Scientific misconduct g. Research Grants: Guide to grant applications, international research collaborations h. Use of ICT in research: List of softwares available for Pre-data, data and post data analysis i. Demonstration of Use of websites and softwares useful in Research: Google scholar, Shodhganga, Mendeley, NDLI, JSTOR	**15**
Unit 2: Professional communication	2.1 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 2.2 Professional communication: Effective communication: Verbal, Non-Verbal, written and Cross-Cultural, Formal communication 2.3 Résumé Skills: Preparation and Presentation	**15**

	a. Difference between a CV, Résumé, and Biodata b. Essential Components of a Good Résumé, Common Errors 2.4 Interview Skills: Preparation and Presentation a. Types of Interview 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 2.5 Meaning, Importance and Types of Group Discussion (GD) a. Procedure of a Group Discussion b. Evaluation of Group Discussion c. Group Discussion: Common Errors	

Course Code 24BUMB3P03	Course Title Field Project in Microbiology I	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

Learner can undertake the field project on topics related to core subjects like

a. Water analysis and potability check
b. standardizing classic fermentation process like curd making
c. study of microflora, normal flora
d. Microbial identification from environmental sample

e. data collection and analysis
f. Survey etc.

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.

References

Sr. No.	Title	Author	Publisher	Edit^{n}	Year
1	Environmental Microbiology	Raina M. Maier, Ian L. Pepper & Charles P. Gerba	Academic Press	2nd	2010
2	Introduction to Environmental Microbiology (e-book)	Barbara Kolwzan, Waldemar Adamiak	Oficyna Wydawnicza PolitechnikiWroclawskiej, Wroclaw	-	-
3	Soil Microbiology	N.S Subba Rao	Oxford and IBH Publishing Co. Pvt Ltd	4th	2000
4	Prescott, Harley & Klein's Microbiology	Willey, Sherwood & Woolverton	McGraw-Hill	7th	2008
5	Microbiology-An evolving science	Joan L. Slonczewski and John W. Foster	W.W Norton Company, NY	4th	-
6	Lehninger Principles of Biochemistry	Nelson and Cox	W H Freeman	4th	2004
7	The Physiology and Biochemistry of Prokaryotes	White, D	Oxford University Press	3rd	2007
8	Biochemistry	Mathews, C.K., K.E. van Holde, D.R. Appling, S, J, Anthony-Cahill	Pearson	4th	2013
9	Research Methodology	C R Kothari	New Age International Publishers	2nd	2004
10	Biochemistry	Zubay	G. L Brown publishers	5th	2020
11	Modern Industrial Microbiology and Biotechnology	Okafor Nduka	Science Publications Enfield, NH, USA	-	2007
12	Industrial Microbiology	Casida L. E.	Reprint, New Age International (P) Ltd, Publishers, New Delhi	2nd	2009

13	Biotechnology A Textbook of Industrial	Crueger W. and Crueger A.	Panima Publishing	2nd	2004
14	Biophysical Chemistry Principles and Techniques	Upadhyay, Upadhyay and Nath	Himalaya	Rev.	2009
15	Principles and techniques of Biochemistry and Molecular Biology	Wilson and Walkar	Cambridge University Press	7th	2010
16	Lehninger Principles of Biochemistry	Nelson and Cox	W.H. Freeman & Company	6th	2013
17	General Microbiology	Stanier, R. Y., M. Doudoroff and E. A. Adelberg	The Macmillan press Ltd	5th	2004
18	Outlines of Biochemistry	Conn, E.E., P. K. Stumpf, G. Bruening and R. Y. Doi	John Wiley & Sons. New York	5th	1987
19	Principles of fermentation technology	P.F. Stanbury, A. Whitaker, S.J. Hall	Butterworth Heinemann, oxford	2nd	2000
20	Fermentation Technology	H.A. Modi	Pointer Publications	8th	2009
21	Industrial Microbiology	A.H. Patel	McMillan India	2nd	2007
22	Food Microbiology	Adam and Moss	New Age International Ltd	3rd	2008
23	Modern Food Microbiology	James M. Jay	Aspen Publishers, Inc	6th	2000
24	Food Microbiology	Frazier William C.	McGraw-Hill	4th	2008
25	Employability Skills (NSQF) - 1st Year (Volume I of II)	-	National Instructional Media Institute	1st	2018
26	Curriculum and Guidelines for Life Skills (Jeevan Kaushal) 2.0	-	University Grants Commission	1st	2023

Semester IV

Course Code 24BUMB4T01	Course Title Replication and Transcription	Credits (02)	No. of lectures in hours 30

COURSE OUTCOME

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

CO1	Understand the chemistry of DNA with respect to melting temperature; non-enzymatic transformations, supercoiling, Meselson-Stahl experiment, Different proteins and enzymes in replication.	L2
CO2	Understand semi-discontinuous, uni directional, bi directional and rolling circuit replication; replication in Prokaryotes and Eukaryotes	L2
CO3	Describe the central dogma, genetic code, RNA classes and transcription process in prokaryotes	L2
CO4	Illustrate the transcription process in eukaryotes alongwith 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 1: DNA Replication	**1.1 Chemistry of DNA** a. Denaturation of double helical DNA: Tm b. Nucleic acid from different species can form hybrids c. Nucleotides and nucleic acids undergo non enzymatic transformations d. Significance of DNA methylation, acetylation and phosphorylation e. DNA supercoiling **1.2 DNA replication in prokaryotes** a. Semi-conservative DNA replication: the 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, pulse chase experiment e. Molecular model of DNA Replication in *E.coli*: Initiation, elongation and termination of replication f. DNA polymerases and their role g. Rolling circle replication **1.3 DNA replication in Eukaryotes** a. Replicons, Initiation of replication, replication enzymes,	**15**

	b. Replicating the ends of chromosomes, telomerase: action and significance	
Unit 2: Transcription	2.1 Central Dogma: An Overview 2.2 Classes of RNA and its significance **2.3 Transcription process, Transcription in bacteria** – a. Initiation of transcription at promoters, b. Elongation of an RNA chain, c. Termination of an RNA chain **2.4 Transcription in Eukaryotes** - Eukaryotic RNA polymerase, 2.5 Transcription of protein- coding genes by RNA polymerase II, Transcription initiation, The structure and production of Eukaryotic mRNAs, Production of mature mRNA in Eukaryotes, Processing of Pre-mRNA to mature mRNA. Self Splicing of Introns, RNA editing 2.6 Genetic code - Nature of genetic code and characteristics of genetic code.	**15**

Course Code 24BUMB4T02	**Course Title Biochemistry**	**Credits (02)**	**No. of lectures in hours 30**

COURSE OUTCOME		
On completion of this course, students will be able to learn:		
CO1	Elaborate on basic properties and classification of enzymes Explain the classification, properties, and catalytic mechanisms of enzymes, along with the influence of environmental factors on their activity.	L6
CO2	Compare types of enzyme inhibition. Apply enzyme kinetics and inhibition principles to interpret multi-substrate reactions and regulatory mechanisms involving cofactors and isozymes.	L5
CO3	Discuss anabolism of carbohydrates	L6
CO4	Represent catabolic pathways of carbohydrates	L4

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	2	0
CO2	3	1	0	0	2	0
CO3	3	0	1	0	0	0
CO4	3	0	1	0	0	0

Units	Description	No of lectures
Unit 1: Enzymology	1.1 History, Definition, Classification and Nomenclature of enzymes 1.2 Chemical Nature, Properties of Enzymes, 1.3 Mechanism of EnzymeAction, 1.4 Michaelis-Menten Equation And Its Derivation; Lineweaver Burk plot 1.5 Overview of Coenzyme: Different Types And Reactions Catalyzed By Enzymes (in tabular form) 1.6 Nicotinic acid:structure,occurrence biochemical function 1.7 Enzyme Kinetics: Saturation Kinetics 1.8 Effect Of Temperature and pH 1.9 Effect of Inhibitors- Reversible and Irreversible,competitive, Non-competitive and uncompetitive inhibitors 1.10 Multi-substrate reactions-Ordered, Random, Ping Pong 1.11 Allosteric effects in enzyme catalyzed reactions-Koshland-Nemethy and Filmer model, Monod, Wymanand Changeux Model	**15**
Unit 2: Carbohydrate Metabolism	**2.1 Introduction to Metabolism** **2.2 Anabolism of Carbohydrates** a. Bacterial gluconeogenesis b. Synthesis of Peptidoglycan **2.3 Catabolism of Carbohydrates**: Major pathways – (with structure and enzymes) a. Glycolysis (EMP), Pasteur effect b. HMP Pathway - Significance of the pathway c. ED pathway d. TCA cycle - Action of PDH, Significance of TCA e. Incomplete TCA in anaerobic bacteria	**15**

	f. Anaplerotic reactions g. Glyoxylate bypass h. Amphibolic role of EMP; Amphibolic role of TCA cycle, Energetics of Glycolysis, TCA and ED pathway sheet only. Format as in Lehninger	

Course Code 24BUMB4T03	Course Title Infection and Immunology	Credits (02)	No. of lectures in hours 30

COURSE OUTCOME

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

CO1	Explain virulence factors and their significances	L2
CO2	Recall basic terminologies related to epidemiology	L4
CO3	Explain the levels of defense and differentiate between innate and acquired immune systems, describing the structure and functions of immune cells and lymphoid organs.	L2
CO4	Analyze the roles of phagocytosis, inflammation, T and B cells and interpret the concepts of antigen and antibody in immune responses.	L4

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	2	1	1	0	1
CO3	3	1	1	0	0	0
CO4	3	2	1	0	0	0

Units	Description	No of lectures
Unit 1: Pathogenicity and Epidemiology of infectious disease	1.1 Host parasite relationships 1.2 types of infections 1.3 Overview of bacterial pathogenesis: Reservoir, Transport, Attachment and colonization, Invasion, Growth and multiplication, escape 1.4 Bacterial Virulence factors 1.5 Toxigenicity: exotoxins and endotoxins 1.6 Pathogenicity islands 1.7 Basic principles of epidemiology: introduction, terminology, Infection cycle, recognition of an infectious disease and Epidemic in population 1.8 Control of epidemics	**15**
Unit 2: Immunology	2.1 Overview of levels of defense, attributes of immune system 2.2 Classification of immune components : innate immunity & acquired immunity 2.3 Cells of immune system: Hematopoiesis, lymphocytes, monocytes & macrophages, granulocytes, mast cells, dendritic cells , NK / NKT cells 2.4 Lymphoid organs : primary and secondary 2.5 Physical barriers and chemical mediators 2.6 Innate mechanisms: Phagocytosis and inflammation 2.7 Main players of adaptive immunity :T and B cells 2.8 Concept of cell mediated and humoral immune responses Introduction to the terms ‘antigen’ and ‘ antibody’	**15**

Course Code 24BUMB4P01	Course Title Practicals Based on 24BUMB4T01 and 24BUMB4T02	Credits (02)	No. of lectures in hours 60

COURSE OUTCOME

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

CO1	Prepare reagents for molecular biology techniques and isolate genomic DNA from E. coli	L5
CO2	Demonstrate proficiency in using a haemocytometer to count blood cells and observing them using the field's stain.	L5
CO3	Analyse the role of key bacterial virulence factors such as catalase, coagulase, hemolysin and lecithinase	L4
CO4	Discover the normal flora of the mouth using media, stain spirochetes with the help of an appropriate staining method and apply the procedure of SDS-PAGE for protein separation.	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	1	2	3	1
CO2	2	3	1	0	3	0
CO3	2	3	1	0	3	0
CO4	2	3	1	1	3	0

Practical no.	Name of the experiment
Practical 1	Reagent preparation for molecular biology techniques
Practical 2	Isolation of genomic DNA from *Escherichia coli*
Practical 3	RBC Count using Haemocytometer
Practical 4	WBC Count using Haemocytometer
Practical 5	Field's staining of Blood film
Practical 6	Understanding virulence factors: Catalase
Practical 7	Understanding virulence factors: Coagulase
Practical 8	Understanding virulence factors: Hemolysin
Practical 9	Understanding virulence factors: Lecithinase
Practical 10	Normal flora of mouth
Practical 11	Spirochete Staining
Practical 12	Electrophoresis of proteins by SDS-PAGE

Course Code 24BUMB4P02	Course Title Practicals Based on 24BUMB4T02 and 24BUMB4T03	Credits (02)	No. of lectures in hours 60

COURSE OUTCOME

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

CO1	Differentiate between oxidative and fermentative metabolic pathways	L4
CO2	Determine the effect of parameters like pH, temperature, substrate concentration and enzyme concentration on enzyme activity	L5
CO3	Estimate glucose concentration using GOD-POD method	L5
CO4	Interpret basic graphical representations	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	2	3	1	1	3	0
CO2	2	2	1	0	3	0
CO3	2	3	1	1	3	0
CO4	3	3	1	0	3	0

Practical no.	Name of the experiment
Practical 1	Study of oxidative and fermentative metabolism
Practical 2	Glucose detection by GOD/POD
Practical 3	Effect of temperature on amylase activity
Practical 4	Effect of pH on amylase activity
Practical 5	Effect of enzyme concentration on amylase activity
Practical 6	Effect of substrate concentration on amylase activity
Practical 7	Effect of inhibitors on amylase activity
Practical 8	Interpretation of Graphs

Course Code 24BU4SEC05	Course Title Clinical Microbiology	Credits (02)	No. of lectures in hours 45

COURSE OUTCOME

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

CO1	Describe the phases of the diagnostic cycle and explain the importance of proper specimen collection and handling in clinical microbiology.	L2
CO2	Compare conventional, rapid and advance methods used for diagnosis	L4
CO3	Apply appropriate diagnostic methods to identify bacteria using conventional and rapid approaches.	L3
CO4	Evaluate the significance and reliability of point-of-care and rapid diagnostic techniques in clinical decision-making and infection control	L4

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	2	2	1	1	1	1
CO4	2	2	1	1	1	1

Units	Description	No of lectures
Unit 1: Clinical Microbiology	1.1 Phases of Diagnostic Cycle 1.2 Clinical Microbiology: Specimen Collection and handling 1.3 Identification Conventional Approach 1.4 Rapid Techniques For pathogen identification 1.5 Other pathogens identified by conventional or rapid diagnostics Point-of-care: Rapid Diagnostics	**15**

	Course Title Practicals based on 24BU4SEC05	Credits (01)	No. of lectures. 30 hr

Practical No.	Name of the experiment
Practical 1	Isolation of organisms on XLD, CLED medium (6)
Practical 2	Biochemical tests: (12) Triple sugar iron slant, Catalase, Oxidase, Lysine decarboxylase yeast

Practical 3	Demonstration of PCR (6)
Practical 4	Enteropluri test (3)
Practical 5	Pathology lab visit (3)

Course Code 24BUMB4T05	Course Title Food Microbiology	Credits (02)	No. of lectures in hours 30

COURSE OUTCOME

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

CO1	Enlist factors responsible for food spoilage	L1
CO2	Describe methods of microbial control in food	L2
CO3	Explain the process of fermentation	L2
CO4	Relate with the day to day examples of fermented food products	L4

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	1	1
CO2	3	1	1	0	1	1
CO3	3	1	1	0	1	1
CO4	3	1	1	0	1	1

Units	Description	No of lectures
Unit 1: Microbes in food and Microbes as food	1.1 Microbes in food:What is growing in my food? 1.2 Effects of microbial growth in food. 1.3 Why does Chapati get spoiled in a day but not the pickle? 1.4 know what controls spoilage 1.5 How to preserve food from spoilage? 1.6 Microbes as food 1.7 Mushrooms: grow them, eat them! 1.8 Spirulina : the green boost 1.9 What are probiotics? What do they do?	**15**
Unit 2: Fermented products	2.1 Overview of fermented food 2.2 Manufacturing of Yogurt 2.3 Chocolate: The sweet side of fermentation! 2.4 Who ‘made’ my cheese ?: learning the process of cheese manufacturing 2.5 “Give me Bread!”: understanding the process of bread making 2.6 Microbes in high spirits!: understanding the process of wine manufacturing	**15**

Course Code 24BU4AEC02	Course Title Basic Bioinformatics and Biostatistics	Credits (02)	No. of lectures in hours 30

COURSE OUTCOME

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

CO1	Explain bioinformatics, its scope, limitations, and types of biological databases including nucleic acid sequence databases.	L2
CO2	Describe protein databases and tools for protein structure visualization and classification.	L2
CO3	Solve problems based on measures of central tendency, measures of dispersion of data and frequency distribution	L3
CO4	Explain the basic concepts of biostatistics including data types, population, sample, frequency distribution and statistical graph	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	2	0	0	0
CO2	3	1	2	0	0	0
CO3	3	0	1	0	0	0
CO4	3	1	1	0	0	0

Units	Description	No of lectures
Unit 1: Basic Bioinformatics	1.1 Definition, aims, scope and limitations of Bioinformatics 1.2 Database and its types 1.3 Biological databases : Primary, secondary, specialized 1.4 Interconnections between biological databases 1.5 pitfalls of biological databases 1.6 Nucleic acid sequence Databases: EMBL, DDBJ 1.7 Protein structure databases: PDB 1.8 Protein sequence databases: PIR, SWISS-PROT 1.9 Protein structural visualization: Rasmol, Swiss-PDB viewer 1.10 Protein structure classification: CATH and SCOP	**15**
Unit 2: Biostatistics	2.1 Introduction to biostatistics 2.2 Types of Data 2.3 Population and sample 2.4 Frequency distribution 2.5 Visualizing data 2.6 Central tendency 2.7 Measures of variation 2.8 Standard error of mean	**15**

Course Code 24BUMB4P03	Course Title Field Project in Microbiology 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 undertake the field project on topics related to core subjects like

1. Enzyme extraction analysis
2. Protein content measurements
3. Data collection and statistical analysis
4. Health related Survey etc.

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 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.

References

Sr. No.	Title	Author	Publisher	Edit^{n}	Year
1	Molecular biology	David Freifelder	Jones & Bartlett Publishers	2nd	1987
2	iGenetics: A Molecular Approach	Peter Russel	Benjamin Cummings	3rd	2010
3	Molecular Biology	Robert Weaver	Mc Graw Hill international	3rd	2005
4	Molecular Cloning A laboratory manual (Volume 1)	Sambrook, Russell	CSHL press	3rd	2001
5	Prescott, Harley & Klein's Microbiology	Willey, Sherwood & Woolverton	McGraw-Hill	7th	2008
6	Microbiology- An evolving science	Joan L. Slonczewski and John W. Foster	W.W Norton Company, NY	4th	-
7	Lehninger Principles of Biochemistry	Nelson and Cox	W H Freeman	4th	2004
8	The Physiology and Biochemistry of Prokaryotes	White, D	Oxford University Press	3rd	2007
9	Biochemistry	Mathews, C.K., K.E. van Holde, D.R. Appling, S, J, Anthony-Cahill	Pearson	4th	2013
10	Fundamentals of Biochemistry	D. Voet and J. Voet	Publisher Wiley plus	5th	2011
11	Biochemistry	Mathews, C.K., K.E. van Holde, D.R. Appling, S, J, Anthony-Cahill	Pearson	4th	2013
12	Outlines of Biochemistry	Conn, E.E., P. K. Stumpf, G. Bruening and R. Y. Doi	John Wiley & Sons. New York	5th	1987
13	Biochemistry	Lubert Stryer	W. H. Freeman and Company	5th	2002
14	Bacterial Metabolism	Gottschalk,G	Springer Verlag	2nd	1979
15	Modern Industrial Microbiology and Biotechnology	Okafor Nduka	Science Publications Enfield, NH, USA	-	2007

16	Industrial Microbiology	Casida L. E.	Reprint, New Age International (P) Ltd, Publishers, New Delhi	2nd	2009
17	Immunology essential and fundamental	S. Pathak, U Palan	Capital Publishing Company	2nd	2005
18	Immunology by Kuby	Kindt, Goldsby, Osborne	W. H. Freeman and Co.	6th	2007
19	Koneman's color atlas and textbook of diagnostic microbiology	Elmer W. Koneman	Lippincott Williams & Wilkins	6th	2006
20	Introduction to Biostatistics	Dr. Pranab Kumar Banerjee	S. Chand Publishing	Rev	2007
21	Biophysical Chemistry Principles and Techniques	Upadhyay, Upadhyay and Nath	Himalaya	Rev.	2009
22	Basic Bioinformatics	S. Ignacimuthu	Narosa Publishing House	2nd	2012

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**
24BUMB3T01	Environmental Microbiology	-	-	-	-	-	-	✔
24BUMB3T02	Microbial Physiology and Protein Analytics	-	-	-	-	-	-	-
24BUMB3T03	Bioprocess Technology and Food Microbiology	-	-	-	-	-	-	✔
24BUMB3P01	Practicals Based on 24BUMB3T01 and 24BUMB3T02	✔	-	✔	✔	-	-	✔
24BUMB3P02	Practicals Based on 24BUMB3T02 and 24BUMB3T03	✔	-	✔	✔	-	-	✔
24BUMB3T05	Environmental Influence and Control of Microbes	-	-	-	-	-	-	✔
24BU3AEC02	Research Methodology and Professional Communication	✔	-	✔	✔	-	✔	-
24BU3SEC05	Electrophoresis and Centrifugation	✔	-	✔	-	-	-	-
24BUMB3P03	Field Project in Microbiology I	-	-	✔	✔	-	✔	✔
23BU3CC606	Departmental activities II	-	-	✔	✔	-	✔	✔

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Curriculum Structure for the Undergraduate Degree Programme S.Y.B.Sc Biotechnology

	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**
24BUMB4T01	Replication and Transcription	-	-	-	-	-	-	-
24BUMB4T02	Biochemistry	-	-	-	-	-	-	-
24BUMB4T03	Infection and Immunology	-	-	-	-	-	-	-
24BUMB4P01	Practicals Based on 24BUMB4T01 and 24BUMB4T02	✔	-	✔	✔	-	-	✔
24BUMB4P02	Practicals Based on 24BUMB4T02 and 24BUMB4T03	✔	-	✔	✔	-	-	✔
24BU4AEC02	Basic Bioinformatics and Biostatistics	-	-	✔	-	-	-	-
24BU4SEC05	Clinical Microbiology	✔	-	✔	✔	-	-	-
24BUMB4T05	Food Microbiology	-	-	-	-	-	-	-
24BUMB4P03	Field Project in Microbiology II	-	-	✔	✔	-	✔	✔
23BU4CC606	Departmental activities III	-	-	✔	✔	-	✔	✔