Vivekanand Education Society's
College of Arts, Science and Commerce (Autonomous)

Sindhi Society, Chembur, Mumbai, Maharashtra – 400 071.

Re-accredited by NAAC "A Grade" in 3rd Cycle (CGPA 3.26)
Best College Award – Urban Area, University of Mumbai (2012-13)
Recipient of FIST Grant (DST) , STAR College Grant (DBT) , and
Recipient of Pradhan Mantri Uchchatar Shiksha Abhiyan (PM-USHA) grant (2023-26)

Affiliated to the

University of Mumbai

Syllabus for

Program: T.Y.B.Sc. (Biotechnology)

(Program code: VESUSBT)

As per Choice Based Credit System (CBCS)
with effect from Academic Year 2025 - 2026

The NEP-2020 presents a chance for India's higher education system to change its teaching focus from one that is very unilateral to one that is holistic. It offers skill-based education, where the programs, courses, and supplemental activities are designed backward to achieve graduation qualities and learning attributes. The learning outcomes-based curriculum framework for a B.Sc. in Biotechnology is designed to give students a thorough grounding in the field and to support them as they successfully pursue further education and research in it while being equipped with the necessary skills at various stages. An effort has been made to incorporate the usage of a gradual build-up of knowledge and contemporary technologies to aid the teaching-learning process for students.The curriculum framework takes into account the need to uphold knowledge and skill standards that are globally competitive in biotechnology and related courses, as well as the development of scientific orientation, an inquiring spirit, problem-solving abilities, and human and professional values that encourage rational and critical thinking in the students. This degree offers a wide range of prospects in several disciplines, including both traditional and applied parts of biotechnology.

Program Outcomes (PO):

On completing B.Sc. (Biotechnology) will be able to:

PO1	Demonstrate analytical skills in applying appropriate science principles and methodologies to solve a wide range of problems.
PO2	Design, carry out experiments, and analyze results by accounting uncertainties in different quantities measured using various scientific instruments.
PO3	Acquire the ability to correlate and draw various inferences.
PO4	Be able to apply the learnings in the academic course to an industrial setup.

Program Specific Outcomes (PSO's)

On completion of B.Sc. (Biotechnology), the student will be able to:

PSO1	Apply the basics of biotechnology to build a strong foundation that will allow them to comprehend emerging and advanced engineering concepts in life sciences.
PSO2	Acquire expertise in the field of biotechnology so that it may be used in industry and research.
PSO3	By integrating disciplinary and interdisciplinary components of biotechnology, students will be able to gain technological knowledge.
PSO4	Recognize the significance of bioethics, intellectual property rights, entrepreneurship, communication, and managerial skills in developing the future generation of Indian industrialists.

T.Y.B.Sc. (BIOTECHNOLOGY)

(SEMESTER V)

Course Code	Types of Courses	Subject Name	Credits	Subject Type
UMMBTS5-301	Major	Medical Microbiology II	2	Theory
UMMBTS5-302	Major	Industrial Biotechnology I	2	Theory
UMMBTS5-303	Major	Tissue Culture Techniques	2	Theory
UMMBTS5-304	Major	Practicals Based on UMMBTS5-301 & UMMBTS5-302	2	Practical
UMEBTS5-311	Major Elective	Molecular Biology II	2	Theory
UMEBTS5-312	Major Elective	Introduction to Biostatistics	2	Theory
UMNBTS5-316	Minor	Biochemistry III	2	Theory
UMNBTS5-317	Minor	Practicals Based on UMNBTS5-316	2	Practical
UVSBTS5-326	VSC	Bioinformatics	2	Theory
UVSBTS5-327	VSC	Practicals Based on UVSBTS5-326	2	Practical
UFPBTS5-371	FP	Field project	2	
		Total Credits	22	

Course Code	Course Title	Credits	No. of Lectures
UMMBTS5-301	**Major - Medical Microbiology II**	**2**	**30**
Course Objectives: The objective of this course is to build up on the knowledge base of Medical Microbiology, learn about other infections in organ systems, and also understand the concept of the use of Antimicrobial therapy **Learning Outcomes:** At the end of the course, the learner will be able to 1. Predict the probable organism causing infection 2. Perform a diagnostic test for confirmation of the causative agent 3. be able to understand the mechanism of action of various antimicrobials			
Unit I **Causative organism 2**	**Respiratory Tract:** ***Mycobacterium tuberculosis*** (3 Lectures) Morphology, Pathogenicity, laboratory diagnosis, Vaccines, and treatment in brief. ***Corynebacterium diphtheriae*** Morphology, antigenic structure, pathogenicity, laboratory diagnosis, Vaccines, treatment in brief (2 Lectures) **Sexually Transmitted diseases:** **Syphilis** *Treponema pallidum* Morphology, Cultivation, Antigenic structure, Pathogenicity, lab diagnosis, treatment (2 Lectures) **HIV** Structure, viral genes, and antigens. Pathogenicity, clinical features of HIV infection, AIDS, detection of HIV infection, prophylaxis(3 Lectures) **Protozoan diseases** **Amebiasis***(Entamoeba histolytica)* Introduction, morphology, lifecycle, transmission, diagnosis, and treatment (1.5 lectures) **Giardiasis** *(Giardia lamblia)* Morphology, habitat, life-cycle, transmission, diagnosis, and treatment (1.5 lectures) **Malaria** Habitat, transmission, life cycle in humans and mosquitoes, incubation period, diagnosis, prophylaxis, and treatment. (2 lectures)	**1**	**15**

Unit II Chemotherapeutic agents	**Discovery and design of antimicrobial agents** (1 lecture) **Classification** of antibacterial agents, selective toxicity, MIC, MLC (2 lectures) **Inhibition of cell wall synthesis** (Mode of action for): Beta-lactam antibiotics: Penicillin, Cephalosporins; Glycopeptides: Vancomycin; Polypeptides: Bacitracin (2 lectures) Injury to the plasma membrane: Polymyxin (1 lecture) **Inhibition of protein synthesis:** Aminoglycosides, Tetracyclines Chloramphenicol, Macrolides, Erythromycin (2 lectures) **Inhibition of Nucleic acid synthesis**: Quinolones, Rifampicin, Metronidazole (2 lectures) **Antimetabolites**: Sulphonamides, Trimethoprim (1 lecture) Drug Resistance: Mechanism, Origin, and Transmission of Drug Resistance (1 lecture) Use and misuse of antimicrobial agents (1 lecture) Antifungal drugs, Antiviral drugs (2 lectures)	**1**	**15**
References	1. Ananthanarayan and Paniker's textbook of microbiology 10th edition. 2. Tortora, Microbiology and Introduction, 9th edition. 3. Jawetz, Melnick, & Adelberg's Medical Microbiology 26th edition 4. Prescott, Harley, and Klein's Microbiology, 7th edition by Joanne M.Willey, Linda M. Sherwood & Christopher J.Woolverton 5. Mim's Medical Microbiology & Immunology 5th edition.		

Course Code	**Course Title**	**Credits**	**No. of Lectures**
UMMBTS5-302	**Major - Industrial Biotechnology I**	**2**	**30**
Course Objectives: To give students a comprehensive understanding of inoculum development and methods for measuring process variables in bioprocessing. To explore the principles and applications of downstream processing (DSP) techniques in bioprocessing. **Learning Outcomes:** By the end of the course the student will be able to: 1. Understand different process parameters that control the fermentation process. 2. Understand downstream processes involved in fermentation.			
Unit I Inoculum development and process Parameter measurement	**Introduction to Inoculum development** (1 lecture); Bacterial and fungal inoculum development with one example each (2 lectures) **Introduction to process parameter** (1 lecture) **Methods of measuring process variables**: Principle,	**1**	**15**

	working, the significance of the following process control sensor probes Temperature (1 lecture) pH (2 lecture) Flow (Gas and liquid) (3 lectures) Pressure (2 lectures) Foam (1 lectures) DO (2 lectures)		
Unit II **Downstream Processes**	**Introduction of DSP** (2 lectures) Foam separation (1 lecture) Types of Precipitation (1 lecture) Filtration (2 lectures) Centrifugation (1 lectures) Chromatography in DSP (2 lectures) **Cell disruption**- physical and chemical methods (2 lectures) **Solvent recovery**, Membrane processes (1 lecture) Drying (1 lecture) Crystallization and Whole broth processing (2 lectures)	**1**	**15**
References	Fermentation technology by Stanbury and Whittkar		

Course Code	**Course Title**	**Credits**	**No. of Lectures**
UMMBTS5-303	**Major - Tissue Culture Techniques**	**2**	**30**
Course Objectives: The course aims at improving the understanding of the basics of plant tissue culture and Animal tissue culture **Learning Outcomes:** By the end of the course the student will be able to: 1. Understand basic concepts of plant Tissue culture, cell lines, and equipment needed in the tissue culture lab. 2. Understand basic concepts of animal Tissue culture, cell lines, and equipment needed in the tissue culture lab.			
Unit I **Plant Tissue Culture**	**History** of plant cell, tissue, organ culture, and research work in India. (1 Lecture) **Laboratory techniques,** Methodology of plant cell, tissue and organ culture, Meristem culture, Callus culture (4 Lectures) Isolation, Benefits of Cell (suspension) culture, and 2 examples of secondary metabolites. **Protoplast culture**: Protoplast fusion and somatic hybridization, Somatic embryogenesis, encapsulated seeds, micropropagation Somaclonal variation, pollen	**1**	**15**

	culture (6 Lectures) embryo culture (2 Lectures) Cryopreservation (2 Lectures)		
Unit II **Animal Tissue Culture**	**Basics of Animal Tissue Culture** (Historical background, Advantages of tissue culture, limitations, major differences in vitro, types of tissue culture) (1 Lecture) **Equipment** needed for tissue culture, laboratory, Incubator, Autoclave, Hot air oven, refrigerators and -20°C deep freezer, Inverted microscope, glassware washing facility, Water purification, Centrifuge, Laminar flow benches (hoods), CO_2 incubator, Balances, pH meter, vortex mixer, magnetic stirrer, research microscope, Pipetting devices, media filtration assembly, controlled rate freezing of cells and liquid N, storage facility and Hemocytometer (5 Lectures) **Glassware and Plasticware** used for Tissue Culture, substrate material for growing cells, Tissue culture vessels (2 Lectures) Tissue culture media Properties and special requirements of media, Balanced salt solutions, **Complete media**: composition of frequently used media, Commonly used antibiotics, Requirement of serum and growth factors, Conditioned medium, serum-free media (3 Lectures) **Type of tissue culture**: Organ and Organotypic Cultures, Primary Culture,s and Culture of cell line (3 Lectures) Cryopreservation and storage (1 Lecture)	**1**	**15**
References	1. Advanced Biotechnology by R C Dubey 2.R. Ian Freshney - Culture of Animal 3 . Principles and Practice of Animal Tissue Culture - Sudha Gangal		

Course Code	Course Title	Credits
UMMBTS5-304	**Major - Practicals Based on UMMBTS5-301 & UMMBTS5-302**	**2**

1. Antibiotic sensitivity testing using Disc diffusion method
2. Synergism of antibiotics
3. Acid-fast staining of *Mycobacterium tuberculosis*
4. Study of different stages of Malarial parasite
5. Minimum Inhibition concentration of antibiotic

6. Minimum Lethal Concentration of antibiotic
7. Antibiotic sensitivity testing using Ditch plate
8. Effect of temperature on microbial growth
9. Effect of pH on microbial growth
10. Alcohol estimation by Cole's method
11. Effect of temperature on alcohol production and estimation
12. Effect of pH on alcohol production and estimation

Course Code	Course Title	Credits	No. of Lectures
UMEBTS5-311	**Major Elective - Molecular Biology II**	**2**	**30**
Course Objectives: This course aims to provide insight into the mechanism of gene expression regulation and tools in molecular biology. **Learning Outcomes:** By the end of the course, the student will be able to: 1. Discuss the mechanisms associated with regulation of gene expression in prokaryotes and eukaryotes. 2. Learners will develop proficiency in a wide range of molecular techniques, including DNA isolation, restriction digestion, electrophoresis, blotting, and DNA manipulation.			
Unit I **Regulation of Gene Expression**	**In Prokaryotes:** Bacteria : Lactose operon of *E.coli* (3 lectures) Tryptophan operon of *E.coli* (2 lectures) Viruses: Lytic / Lysogenic Regulation (3 lectures) **In Eukaryotes :** Operons in Eukaryotes (1 lecture) **Control of Transcriptional Initiation** (2 lectures) i. By activator ii. By repressors iii. Role of chromatin in regulating gene transcription (repression of gene activity by histone and chromatin remodeling **Gene Silencing and Genomic Imprinting** (2 lectures) i. Gene silencing at a telomere ii. Gene silencing by DNA methylation iii. Genomic imprinting **Post-Transcriptional Control**: RNA Interference (2 lectures)	**1**	**15**
Unit II **Tools and Techniques in Molecular Biology**	**Introduction to isolation of gene of interest (Overview only)**: Isolation and purification of DNA, Restriction digestion, electrophoresis, blotting, cutting and joining DNA, methods of gene transfer in	**1**	**15**

	prokaryotes and eukaryotes (2 lectures) **Recombinant selection and screening methods**: i. Blotting techniques: Southern, Northern, and Western blotting (3 lectures) ii. Hybridization techniques: Genetic, immunochemical, nucleic acid hybridization, HART, HRT (3 lectures) **Molecular Markers:** Classical DNA markers (RFLP, RAPD, AFLP, SSR, SNP) (4 lectures) **Cloning strategies:** Genomic DNA libraries, cDNA libraries, chromosome walking and jumping (3 lectures)		
References	1. iGenetics A Molecular Approach 3rd Edition Peter J. Russell-Pearson Education 2. Genetics, 5th Edition Peter J. Russell-Pearson Education 3. Molecular Biotechnology-Principles and Applications of Recombinant DNA Technology 3rd Edition Glick B.R., Pasternak J.J., Patten C.L. 4. Biotechnology 3rd Edition S.S. Purohit. 5. Genomes 3rd Edition T.A. Brown. 6. Biotechnology B.D. Singh. 7. Gene Cloning and DNA Analysis 6th Edition T.A. Brown. 8. Plant Breeding from Laboratories to Fields by Sven Bode Andersen		

Course Code	**Course Title**	**Credits**	**No. of Lectures**
UMEBTS5-312	**Major Elective- Introduction to Biostatistics**	**2**	**30**
Course Objectives: The objective of this course is to learn and understand basic concepts of Biostatistics. **Learning Outcomes:** By the end of the course the student will be able to 1. Analyse charts, tables, and graphs based on statistical data 2. Apply statistical tools and test for interpretation of data			
Unit I **Measures of Central Tendency & Dispersion**	**Definition and Importance of Statistics in Biology** (2 lectures) Types of Data, Normal and Frequency Distribution (2 lectures) **Representation of Data and Graphs** (Bar Diagrams, Pie Charts, and Histogram, Polygon, and Curve) (5 lectures) **Types of population sampling** Measures of Central tendency (For Raw, Ungroup &	**1**	**15**

	group Data) Mean, Median, Mode (4 lectures) Measures of Dispersion Range, Variance, Coefficient of Variance.Standard Deviation. Standard Error. (3 lectures)		
Unit II: **Significance testing**	Theory and problems based on- coefficient of correlation and regression analysis (4 lectures) Steps in testing a statistical hypothesis (3 lectures) **Parametric Tests**: Z Test – Single Mean and Two Means (3 lectures) t-Test – Single Mean, Paired and Unpaired; (2 lectures) Chi-Square test (3 lectures)	**1**	**15**
References	1. Biostatistics by Arora and Malhan 2. Introductions to Biostatistics by Mahajan		

Course Code	**Course Title**	**Credits**	**No. of Lectures**
UMNBTS5-316	**Minor - Biochemistry III**	**2**	**30**
Course Objectives: Understand the fundamental concepts of enzymes explore enzyme functionality and study enzyme inhibition and regulation. To understand key metabolic pathways and analyze energy production and regulation **Learning Outcomes:** Demonstrate a solid understanding of enzymes 1. Explain the mechanisms behind enzyme action and analyze factors influencing enzyme activity 2. Comprehend the core metabolic pathways and analyze energy production and metabolism			
Unit I **Enzymology**	**Definition, Classification, Nomenclature,** (1 Lecture) Chemical Nature, (1 Lecture) Properties of Enzymes, (2 Lectures) Mechanism of Enzyme Action, (2 Lectures) Active Sites, Enzyme Specificity, (1 Lecture) Effect of pH, Temperature, (1 Lecture) Substrate Concentration on Enzyme Activity, Enzyme Kinetics, Michaelis-Menten Equation, (3 Lectures) **Types of Enzyme Inhibitions** - Competitive, Uncompetitive, Non-Competitive, Allosteric Modulators, (3 Lectures) Co-Factors, Zymogens (1 Lecture)	**1**	**15**
Unit II **Carbohydrate Catabolism**	**Glycolytic Pathway** and its Regulation, (3 Lectures) **Citric Acid Cycle** and its Regulation; (3 Lectures) Gluconeogenesis; (2 Lecture)	**1**	**15**

	Pentose Phosphate Pathway; (2 Lecture) (Sequence of Reactions, Regulation, Energy Yield and Metabolic disorders of the above pathways) **Electron Transport System** : Electron Transport and Oxidative Phosphorylation. (4 Lectures) Inhibitors of ETS. (1 Lecture)		
References	1. Lehninger's Principles of Biochemistry by Nelson and Cox 4th Edition		

Course Code	Course Title	Credits
UMNBTS5-317	**Minor - Practicals Based on UMNBTS5-316**	**2**

1. Detection of amylase in potato extract
2. Effect of pH on enzyme activity
3. Effect of temperature on enzyme activity
4. Effect of substrate concentration on enzyme activity
5. Effect of inhibitor concentration on enzyme activity
6. Isolation of mitochondria
7. Detection of lactate dehydrogenase in serum
8. Detection of Blood Glucose

Course Code	Course Title	Credits	No. of Lectures
UVSBTS5-326	**VSC - Bioinformatics**	**2**	**30**
Course Objectives: To develop the student's understanding of computer and bioinformatics **Learning Outcomes:** By the end of the course, the student will be able to: 1. Understand computer hardware and basics of algorithm 2. Gain an understanding of the basic concepts of bioinformatics. 3. Understand the tools used in bioinformatics.			
Unit I **Introduction to computers and biological databases**	**Introduction to computers:** Overview and functions of a computer system, Input and output devices, and Storage devices (3 lectures) Algorithm (2 lectures) Introduction to MS-word, Excel, and PowerPoint (3 lectures) **Basics of Bioinformatics** Introduction to bioinformatics, the scope of bioinformatics, bioinformatics, and the Internet (1 lecture) **Biological Databases:**	**1**	**15**

	Classification of databases - raw and processed databases; Primary (NCBI), Secondary (PIR), and Tertiary or composite (KEGG) databases; structure and sequence databases. (4 lectures) **Specialized Databases**: Protein pattern databases; Protein structure and classification databases (CATH/SCOP) (2 lectures) **Genome information resources:** DNA Sequence databases, specialized genomic Resources (1 lecture) Protein databases based on composition, motifs, and patterns (1 lecture)		
Unit II **BLAST, sequence alignment and visualisation**	**BLAST and Sequence Alignment** BLAST and its types (2 lectures) Retrieving Sequence using BLAST (1 lecture) **Pairwise Alignment :** Identity and similarity; global and Local alignment; pairwise database searching (4 lectures) **Multiple Sequence Alignment:** Goal of multiple sequence alignment; Computational complexity; manual methods; simultaneous methods; progressive methods; databases of multiple alignments; secondary database searching; analysis packages; MSA and phylogenetic Trees (lectures) **Protein structure visualization software:** Rasmol/Raswin (1 lecture)	**1**	**15**
References	1. Goel, A. (2010). Computer Fundamentals. India: Pearson Education. 2. Computer Literacy BASICS: A Comprehensive Guide to IC3 3. Concept on Bioinformatics- Rajendra Prasad Pangeni 4. Bioinformatics methods and applications- S.C. Rastogi 5. http://www.rasmol.org/software/RasMol_2.7.5_Manual.html		

Course Code	Course Title	Credits
UVSBTS5-327	**VSC - Practicals Based on UVSBTS5-326**	**2**

1. Making a MS Word document
2. Making a PPT
3. Use of MS Excel for data analysis
4. Writing algorithm
5. Familiarization with NCBI, EMBL, DDBJ, PIR, and KEGG Databases.
6. Classification of Proteins using CATH/SCOP.
7. Visualization of PDB Molecules using Rasmol/Raswin.
8. Use of NCBI BLAST Tools
9. Pairwise and Multiple Sequence Alignment
10. Construction of Phylogeny