Janardan Bhagat Shikshan Prasarak Sanstha's

Changu Kana Thakur
Arts, Commerce and Science College, New Panvel
(Autonomous)

Re-accredited A+ Grade by NAAC
'College with Potential for Excellence 'Status Awarded by University Grants Commission
'Best College Award' by University of Mumbai

Affiliated to University of Mumbai with an Autonomous status

Revised Syllabus for

Program: B.Sc. Biotechnology

S.Y. B.Sc. Biotechnology

Choice based Credit & Grading system (60:40)

(To be implemented from the academic year (2020-2021)

Preamble:

Biotechnology is one of the youngest branches of Life Science, which has expanded and established as an advanced interdisciplinary applied science in last few years. Biotechnology at the core envisages the comprehensive study of Life and the Interdisciplinary potential of Biotechnology has led to a unique status for Biotechnology in Research and Industry.

Biotechnology has its applications in almost every field touching practically every human activity. The applied aspect of Biotechnology is now getting established with its applications in Industry, Agriculture, Health and Environment, Biotechnology is the lead science expanding exponentially.

Biotechnology demands a trained, skilled human resource to establish the Industry and Research sectors. The field is novel and still expanding which demands inputs in Infrastructure and Technology. The need of the hour is to design appropriate syllabi which keeps pace with changing times and technology with emphasizes on applications while elucidating technology in depth. The syllabi till today had been sufficient to cater to the needs of students for building up their careers in industry and research. However, with the changing scenario at local and global level, we feel that the syllabus orientation should be altered to keep pace with developments in the education and industrial sector. Theory supplemented with extensive practical skill sets will help a graduate student to avail the opportunities in the applied fields (research, industry or institutions), without any additional training. Thus, the college itself will be developing the trained and skilled man-power.

Biotechnology being an interdisciplinary subject, this restructured syllabus will combine the principles of physical, chemical, and biological sciences along with developing advanced technology. Biotechnology curricula are operated at two levels viz. undergraduate and postgraduate. The undergraduate curricula are prepared to impart primarily basic knowledge of the respective subject from all possible angles while postgraduate syllabus emphasizes on more applied courses. In addition, students are to be trained to apply this knowledge particularly in day-to-day applications of biotechnology and to get a glimpse of research.

Speciality Programme: Bachelor of Science (B.Sc.)
B.Sc. in Biotechnology

Eligibility: As per University of Mumbai rules.

Scheme of Examination

The performance of the learners shall be evaluated into two components. The learner's Performance shall be assessed by Internal Assessment with 40% marks in the first component by conducting the Semester End Examinations with 60% marks in the second component. The allocation of marks for the Internal Assessment and Semester End Examinations are as shown below: -

A) Internal Assessment: 40 % **40 Marks**

Sr. No.	Particular		Marks
01	One periodical class test / online examination to be conducted in the given semester		20 Marks
02	One case study / project with presentation based on curriculum to be assessed by the teacher concerned		15 Marks
	Presentation	10 Marks	
	Written Document	05 Marks	
03	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities		05 Marks

Question Paper Pattern
(Periodical Class Test for the Courses at Under Graduate Programmes)

Maximum Marks: 20
Duration: 40 Minutes
Questions to be set: 02
All Questions are Compulsory

Question No.	Particular	Marks
Q. 1	Match the Column/Fill in the Blanks/Multiple Choice Questions/Answer in One or Two Lines.(Concept based Questions) (1 Marks / 2 Marks each)	10 Marks
Q. 2	Answer in Brief(Attempt any Two of the Three) (5 Marks each)	10 Marks

B) Semester End Examination: 60 % **60 Marks**

Undergraduate Programmes of S. Y. B.Sc. (Sem. III & IV)

Duration: The examination shall be of 2 hours duration.

Question Paper Pattern

Theory question paper pattern
1. There shall be four questions of 15 marks each (30 marks with internal options). 2. On each unit there will be one question and fourth question will be based on entire syllabus. 3. All questions shall be compulsory with internal options. 4. Question may be subdivided into sub-questions a, b, c… and the allocation of marks depends on the weightage of the unit.

Passing Standard

The learners to pass a course shall have to obtain a minimum of 40% marks in aggregate for each course where the course consists of Internal Assessment and Semester End Examination. The learners shall obtain minimum of 40% marks (i.e. 16 out of 40) in the Internal Assessment and 40% marks in Semester End Examination (i.e. 24 Out of 60) separately, to pass the course and minimum of Grade D, wherever applicable, to pass a particular semester. A learner will be said to have passed the course if the learner passes the Internal Assessment and Semester End Examination together.

Note: As per previous ordinance there will not be any internal examination for practical.

S.Y. B.Sc. Biotechnology

Semester -III				
Course Code	**Course Type**	**Course Title**	**Credits**	**Lectures / Week**
UBT3BPH	Core Subject	Biophysics	2	3
UBT3APC	Core Subject	Applied Chemistry-I	2	3
UBT3IMM	Core Subject	Immunology	2	3
UBT3CBC	Core Subject	Cell Biology and Cytogenetics	2	3
UBT3MOB	Core Subject	Molecular Biology	2	3
UBT3BPT	Skill Enhancement Elective	Bioprocess Technology	2	3
UBT3RSM	General Elective	Research Methodology	2	3
UBT3PR1	Core Subject Practical	Practical of UBT3BPH and UBT3APC	2	6
UBT3PR2	Core Subject Practical	Practical of UBT3IMM and UBT3CBC	2	6
UBT3PR3	Core Subject and Skill Enhancement Elective Practical	Practical of UBT3MOB and UBT3BPT	2	6

S.Y. B.Sc. Biotechnology

Semester -IV				
Course Code	**Course Type**	**Course Title**	**Credits**	**Lectures /Week**
UBT4BIC	Core Subject	Biochemistry	2	3
UBT4APC	Core Subject	Applied Chemistry-II	2	3
UBT4MEM	Core Subject	Medical Microbiology	2	3
UBT4ENB	Core Subject	Environmental Biotechnology	2	3
UBT4BBI	Core Subject	Biostatistics and Bioinformatics	2	3
UBT4MOD	Skill Enhancement Elective	Molecular Diagnostics	2	3
UBT4END	General Elective	Entrepreneurship Development	2	3
UBT4PR1	Core Subject Practical	Practical of UBT4BIC and UBT4APC	2	6
UBT4PR2	Core Subject Practical	Practical of UBT4MEM and UBT4ENB	2	6
UBT4 PR3	Core Subject and Skill Enhancement Elective Practical	Practical of UBT4 BBI and UBT4 MOD	2	6

SEMESTER-III THEORY

SEMESTER-III
Paper-I BIOPHYSICS (UBT3BPH)

Course Objective:
The objective of this course is to have a firm foundation of the fundamentals and applications of current biophysical theories.

Learning Outcome: By the end of the course the student will:

- Develop an understanding of the different aspects of classical Physics.
- Be able to relate principles of Physics to applications and techniques in the field of Biology such as Microscopy, Spectroscopy and Electrophoresis.

Unit	Title	Credits	Lectures
UNIT I Spectroscopy and Microscopy	**Lasers:** Properties and Applications of Laser. **Spectroscopy:** • Introduction to Electromagnetic Radiation. • Types and Properties of Spectra; • Basic Laws of Light Absorption. • Spectrophotometer: -Principle, Instrumentation and Applications; • UV-Vis Spectrophotometer, Single and Dual Beam Spectrophotometer. **Microscopy:** • Electron Microscopy- principle, instrumentation applications and Preparation of Specimen, SEM, TEM. Fluorescence Microscopy.	**2**	**15**
UNIT II Heat, Sound, and Fluid Dynamics	**Heat:** • Concept of Temperature; Modes of Heat • Transfer; Measuring Temperature; Platinum Resistance Thermometer; Thermocouple and Thermistors. **Sound:** • Types of Sound Waves - Audible, Ultrasonic • and Infrasonic Waves; Doppler Effect; • Applications of Ultrasonic Waves. **Fluid Dynamics:** **Viscosity:** • Definition Flow of Liquids through Capillaries; Stokes' Law; Terminal Velocity. • Determination of 'η' by Falling Sphere Method; Viscosity Estimation by Oswald's • Viscometer. **Surface Tension:** • Definition - Surface Tension and Surface • Energy; Capillary Action; Angle of Contact; • Wettability; Temperature Dependence of • Surface Tension. • Applications in Biology.		**15**

UNIT III Electrophoretic Techniques	**Electrophoresis:** • Migration of Ions in an applied electric field; Factors affecting Electrophoretic Mobility; Moving Boundary Electrophoresis; • Principle of Electrophoresis; Supporting Matrix; • Paper Electrophoresis; AGE; • Native and SDS PAGE (reducing and • non-reducing, continuous and discontinuous); • IEF and 2D PAGE. • Staining and Detection Methods; • Gel- Documentation. Applications in biology		**15**

SEMESTER-III
Paper-II APPLIED CHEMISTRY–I (UBT3APC)

Course Objective:
- The objective of this course is to have a firm foundation of the fundamentals and applications of Organic and Green Chemistry.

Learning Outcome: By the end of the course the student will be able to:
- Develop an understanding of the different aspects of Organic and Green Chemistry.
- Discuss role of Organic Compounds in Biology and Synthesis of Organic Compounds.
- Discuss role of Green Chemistry and its application in Industry.

Unit	Title	Credits	Lectures
UNIT I Organic Chemistry	**Introduction to types of Organic Reactions:** • Addition, Elimination, & Substitution reactions. • Mechanisms of Organic Reactions and Reactive intermediates, Methods of generation • General reactions of the following reactive intermediates: • Carbocation, Carbanion, Carbon free radical • Essential & Non-essential elements in biological system. • Role of metal ions in biological system. • Biological role of caboxyperoxidases, catalases and peroxidases of organic compounds.	**2**	**15**
UNIT II Synthesis of Organic Compounds	**Synthesis of Organic Compounds:** • Criteria for Ideal Synthesis, Selectivity and Yield. • Linear and Convergent Synthesis and • Multicomponent Reactions. • Microwave Assisted Organic Synthesis, • Ultrasound in Synthesis and Polymer Supported Synthesis.		**15**

UNIT III Green Chemistry and Synthesis	**Green Chemistry and Synthesis:** • Introduction to Green Chemistry; • Need and Relevance of Green Chemistry; Principles of Green Chemistry. • Green Synthesis in Industry: Green Materials, • Green Reagents, Green Solvents and Green • Catalysts.		**15**

SEMESTER-III
Paper-III IMMUNOLOGY (UBT3IMM)

Course Objective:

- The objective of this course is to familiarize students with the Immune Effector Mechanisms and various Immunotechniques.

Learning Outcome: By the end of the course the student will be able to:

- Understand the role of different types of Cells, Effector Molecules and Effector Mechanisms in Immunology.
- Understand the principles underlying various Immunotechniques.

Unit	Title	Credits	Lectures
UNIT I Effectors of Immune Response	• Haematopoiesis; Cells of the Immune System; • Primary and Secondary Lymphoid Organs. • Complement System- • Classical, Alternate and Lectin; • Regulation and Biological Effects of Complement System; • Deficiencies of Complement System	**2**	**15**
UNIT II Generation of B-Cell and T-cell Response	• Major Histocompatibility Complex-MHC-I and MHC-II- General Organization, Structures and Peptide Interactions. • Antigen processing and presentation: • Endocytic and Exocytic Pathways. • T-cell and B-cell Maturation, activation and differentiation.		**15**
UNIT III Immuno-Techniques	**Precipitation Reactions:** • Immunoprecipitation, Imunoelectrophoresis, • CIEP, Rocket Electrophoresis and • 2-D Immunoelectrophoresis. **Agglutination Reactions:** • Passive, Reverse Passive, Agglutination Inhibition. • Coomb's Test; Complement Fixation Tests, • RIA, ELISA, ELISPOT, Chemiluminescence, Western Blot, Immunofluorescence, Flow Cytometry. • Affinity chromatography. **Alternatives to Antigen-Antibody Reactions.**		**15**

SEMESTER-III
Paper-IV CELL BIOLOGY AND CYTOGENETICS (UBT3CBC)

Course Objective:

- The objective of this course is to have a firm foundation in the fundamentals of Cell Biology and Cytogenetics.

Learning Outcome: By the end of the course the student will be able to:

- Develop an understanding of the Cytoskeleton and Cell Membrane.
- Discuss the principles underlying Linkage, recombination and Mapping.

Unit	Title	Credits	Lectures
UNIT I Cytoskeleton	Overview of the Major Functions of Cytoskeleton. **Microtubules:** Structure and Composition. • MAPs: Functions- Role in Mitosis, Structural Support and Cytoskeleton Intracellular Motility. • Motor Proteins: Kinesins, Dynein; MTOCs. Dynamic Properties of Microtubules. • Microtubules in Cilia and Flagella. **Microfilaments:** • Structure, Composition, Assembly and • Disassembly. • Motor Protein: Myosin. • Muscle Contractility: Sliding Filament Model. Actin Binding Proteins: Examples of Non- • Muscle Motility. **Intermediate Filaments:** • Structure and Composition; Assembly and • Disassembly; Types and Functions. **Drugs targeting cytoskeleton-** • Colchicine, Cytochalasins, Taxol, Phalloidin, Vinblastine	**2**	**15**
UNIT II Cell Membrane	• Uptake of Nutrients by Prokaryotic Cells; Cell Permeability. • **Principles of Membrane Transport-** • Transporters and Channels; Active Transport, Passive Transport; Types of Transporters; • Types of ATP Driven Pumps - Na^+ K^+ Pump. • Cell Junctions; Cell Adhesion and Extracellular Material, • Microvilli; Tight Junctions, Gap Junctions; • Cell Coat and Cell Recognition.		**15**
UNIT III Genetic Linkage,	**Genetic Linkage:** • Morgan's experiment in Drosophila, Corn experiment **DNA recombination:**		**15**

Crossing Over and Chromosomal Mapping	• Crossing over; Holliday model of recombination; • Gene conversion and mismatch repair **Gene Mapping in eukaryotes:** • Two-point Cross; Three-point Cross • Pedigree analysis- Dominant and Recessive traits for Autosomal and Sex Chromosome; Tetrad analysis		

SEMESTER-III
Paper-V MOLECULAR BIOLOGY (UBT3MOB)

Course Objective:
- The objective of this course is to have an insight into mechanism of Gene Expression and Regulation.

Learning Outcome: By the end of the course the student will be able to:
- Discuss the mechanisms associated with Gene Expression at the level of Transcription and Translation.
- Impart the knowledge of molecular Biology Techniques

Unit	Title	Credits	Lectures
UNIT I Gene Expression-Transcription	**Gene Expression- an Overview** **Transcription Process in Prokaryotes:** • RNA Synthesis; Promoters and Enhancers; • Initiation of Transcription at Promoters; • Elongation and Termination of an RNA Chain. **Transcription in Eukaryotes:** • Eukaryotic RNA Polymerases; Eukaryotic • Promoters; Transcription of Protein Coding • Genes by RNA Polymerase; Eukaryotic • Mrna's; Transcription of other genes; • Spliceosomes; RNA editing.	**2**	**15**
UNIT II Gene Expression-Translation	**Nature of Genetic Code.** Wobble Hypothesis. **Translation:** • Process of Protein Synthesis (Initiation, • Elongation, Translocation, Termination); • Post Translation Modifications. • Protein sorting. • **Introduction to operon concept**		**15**
UNIT III R-DNA Technology	• **Enzymes in genetic engineering:** • DNA Polymerases, Restriction Endonucleases, • Ligases, Reverse Transcriptases, Nucleases, Terminal Transferases, Alkaline Phosphatases, • Polynucleotide kinase **Gene cloning vectors:** • Plasmids, Bacteriophage Vectors- insertion		**15**

	• vectors, replacement vectors, Cosmids, Phagemids, Vectors for Plant and Animal Cells, • Shuttle Vectors, YAC Vectors, Expression Vectors • **Gene cartridges**		

SEMESTER-III
Paper-VI BIOPROCESS TECHNOLOGY (UBT3BPT)

Course Objective:

- The objective of this course is to understand the basics skills applied in Fermentation Technology and build a foundation for more advanced studies in Bioprocess Technology.

Learning Outcome: By the end of the course the student will be able to:

- Develop an understanding of the various aspects of Bioprocess Technology.
- Develop skills associated with screening of Industrially Important Strains.
- Understand principles underlying design of Fermenter and Fermentation Process.

Unit	Title	Credits	Lectures
UNIT I Microorganisms in Industrial Processes	**Types of Microorganisms used in Industrial Processes:** • Bacteria, Actinomycetes, Fungi and Algae. **Screening and Maintenance of Strains:** • Primary Screening and Secondary Screening; Cultivation; Preservation of Industrially Important Microbial Strains.	**2**	**15**
UNIT II Fermentor and Fermentation Processes	**Design of a Fermentor:** • Stirred Tank Fermentor- Basic Design; Parts of a Typical Industrial Fermentor. **Fermentation Media:** • Components; Design and Optimization. **Sterilization:** • Sterilization of Fermentor and Fermentation Media. **Process Parameters:** • pH, Temperature, Aeration, Agitation, Foam **Types of Fermentation:** • Surface and Submerged; Batch and Continuous, Aerobic and Anaerobic. **Product Isolation and Purification. Study of Representative Fermentation Processes:** Outline of Penicillin and Ethanol Production by Fermentation along with flow diagram**.**		**15**
UNIT III In-vivo and In-vitro Assay of	**Assay of Industrial Products:** • Chemical and Biological; Types and Subtypes; Kinetics. • Advantages and Disadvantages. • Half-Life Determination of Pharmacological		**15**

Industrial Products	Products. • Overview of Bioavailability and Bioequivalence Studies		

SEMESTER-III
Paper-VI RESEARCH METHODLOGY (UBT3RSM)

Course Objective: The objective of this course is to develop Research Aptitude, Logical Thinking and Reasoning.

Learning Outcome: By the end of the course the student will be able to:

- Understand basic principles of Research Methodology and identify a Research Problem.
- Understand a general definition of Research Design.
- Understand process of Scientific Writing.
- Identify the overall Process of Designing a Research Study from its inception to its Report.

Unit	Title	Credits	Lectures
UNIT I Introduction to Research Methodology and Research Problem	• Meaning of Research; Objectives of Research; • Motivation in Research; Types of Research; Research Process; Criteria of Good Research; What is a Research Problem? Selecting the Problem; Necessity of Defining the Problem; Technique Involved in Defining a Problem. Developing a Research Plan, Types of Data and Data collection Methods,Case Study Method	**2**	**15**
UNIT II Research Design, Interpretation and Report Writing	• Meaning of Research Design; Need for Research Design; Features of a Good Design; Important Concepts Relating to Research Design; Different Research Designs; Basic Principles of Experimental Designs; • Interpretation and Report Writing • Meaning of Interpretation, Why Interpretation? Technique of Interpretation, Precautions in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports • Oral Presentation		**15**
UNIT III Introduction to Scientific Writing	• **Introduction and Process of Scientific Writing :** • Types of Scientific writing, Process of Scientific Writing: Thinking, Planning, Rough Drafts and Revising Contents.		**15**

	• How to write a research paper and research project proposal? , • Abstract Writing, Main content, • Hour- glass Model of Research paper writing, Review of Literature, Bibliography, • Ethics in Scientific writing and research Publication: Plagiarism-Introduction to Plagiarism, Examples of Plagiarism		

PRACTICALS

SEMESTER III		
Course Code	**Title**	**Credits**
UBT3PR1 (Practical of UBT3BPH and UBT3APC)	1. Study of Absorption Spectra of Colored Compounds ($CuSO_4$, $KMnO_4$). 2. Verification of Beer-Lambert's Law. 3. Extraction of Plasmid DNA and Separation by Agarose Gel Electrophoresis. 4. Determination of Purity of Plasmid DNA using UV Spectrophotometry. 5. Study of the Structure and Function of an Electron Microscope (Visit /Video Demonstration - including Sample Preparation and Staining). 6. Demonstration of Structure and Working of a Fluorescence Microscope (Stained Preparation). 7. Electrophoresis of Proteins by PAGE and SDS-PAGE. 8. Purification of any TWO Organic Compounds by Recrystallization Selecting Suitable Solvent. 9. Organic Estimations: Acetone, Amide, Benzoic Acid. 10. Organic Preparations : a. Acetylation of Primary Amine (Preparation of Acetanilide). b. Base Catalyzed Aldol Condensation (Synthesis of Dibenzalpropanone).	**2**
UBT3PR2 (Practical of UBT3IMM and UBT3CBC)	1. Complement Fixation Test (CFT). 2. Passive Agglutination- RA Factor Test. 3. Immunoelectrophoresis. 4. ELISA (Kit-based) - HEPALISA. 5. DOT-ELISA. 6. Western Blotting - Demonstration. 7. Flow Cytometry - Lab Visit.	**2**

	8. Mapping based on Tetrad Analysis and Three Point Cross. 9. Pedigree Analysis- Autosomal and Sex-Linked.	
UBT3PR3 (Practical of UBT3MOB and UBT3BPT)	1. Study of *E.coli* Diauxic Growth Curve- (Lactose and Glucose). 2. Study of lac Gene Expression using Blue-White Selection. 3. Expression of β-galactosidase and Measurement of Activity. 4. Screening for an Antibiotic Producing Strain of Microorganism. 5. Screening for an Alcohol Producing Strain of Microorganism. 6. Lab Scale Production of Penicillin (Static and shaker). 7. Purification of Penicillin from Broth Culture of Penicillium spp. by Solvent Extraction. 8. Lab Scale Production of Ethanol. 9. Purification of Ethanol from Broth Culture of *Saccharomyces* spp. by Distillation. 10. Estimation of Penicillin from Recovered Broth by Chemical (Iodometric) Method. 11. Estimation of Penicillin from Recovered Broth by Biological (Bioassay) Method. 12. Estimation of Alcohol from Recovered Broth by Dichromate Method.	**2**

SEMESTER-IV THEORY

SEMESTER-IV
Paper-I BIOCHEMISTRY (UBT4BIC)

Course Objective:

- The objective of this course is to gain an insight into the Metabolic Processes associated with Catabolism of Carbohydrates, Amino Acids, Lipids and Nucleotides.

Learning Outcome: By the end of the course the student will be able to:

- Discuss the Metabolic Pathways of Carbohydrates, Amino Acids, Lipids and Nucleotides.
- Explain the Role of Energy Rich Molecules in Metabolism.

Unit	Title	Credits	Lectures
UNIT I Carbohydrate Metabolism, ETS and Energy Rich Compounds	**Carbohydrate Metabolism:** • Glycolytic Pathway and its Regulation, Homolactic Fermentation; Alcoholic Fermentation; Energetics of Fermentation; Citric Acid Cycle and its Regulation; • Gluconeogenesis; Pentose Phosphate Pathway; Glyoxalate Pathway; Reductive TCA. • (Sequence of Reactions, Regulation, Energy Yield and Metabolic Disorders of the above Pathways) **Electron Transport System:** • Electron Transport and Oxidative • Phosphorylation. Inhibitors of ETS. **Energy Rich Compounds:** • ATP as Energy Currency, Structure of ATP, • Hydrolysis, Other Energy Rich Compounds • other than ATP like PEP, Creatine Phosphate	**2**	**15**
UNIT II Amino Acid Metabolism	**Amino Acid Breakdown:** • Deamination, Transamination, Urea Cycle, • Breakdown of Glucogenic and Ketogenic, Amino Acids. **Amino Acids as Biosynthetic Precursors:** • Biosynthesis of Epinephrine, Dopamine, • Serotonin, GABA, Histamine, Glutathione. • (Sequence of Reactions, Regulation and • Metabolic Disorders of the above Pathways)		**15**
UNIT III Lipid and Nucleotide Metabolism	**Lipid Metabolism:** • Mobilization, Transport of Fatty Acids. • Beta, Alpha and Omega Oxidation of Saturated • Fatty Acids; Oxidation of Unsaturated Fatty Acids; Oxidation of Odd Chain Fatty Acids. • Energy Yield, Ketone Body Breakdown to • Yield Energy.		**15**

	• (Sequence of Reactions, Regulation, Energy Yield and Metabolic Disorders of the above Pathways) **Nucleotide Metabolism:** • Degradation of Purines and Pyrimidines.		

SEMESTER-IV
Paper-II APPLIED CHEMISTRY – II (UBT4APC)

Course Objective:
- The objective of this course is to have a firm foundation of the fundamentals and applications of current Chemical Theories for the Physical World.

Learning Outcome: By the end of the course the student will be able to:
- Develop an understanding of the different aspects of Analytical Chemistry.
- Gain knowledge of Natural Product Chemistry and related acquired skills.
- Gain an understanding of basic concepts in Polymer Chemistry and Nanomaterials.

Unit	Title	Credits	Lectures
UNIT I Sampling and Separation techniques	**Sampling:** • Importance of sampling and sampling techniques. • Types of sampling- Random and Non-Random, • Sampling of solids, Liquids and Gases. **Separation techniques:** • Solvent Extraction • Partition Coefficient and Distribution Ratio, Extraction Efficiency, Separation Factor, Role of Complexing Agents, Chelation, Ion Pair Formation, Solvation, Soxhlation • Centrifugation: Basic principles of sedimentation, Instrumentation and application of centrifuges and ultra-centrifuges • Density gradient centrifugation	**2**	**15**
UNIT II Natural Product Chemistry	**Natural Product Chemistry:** • Primary and secondary metabolites. **Classification of natural products:** • Alkaloids, terpenoids, saponins, coumarin, Phenolics, Essential oils and steroids. **Herbs with medicinal properties:** • Curcuma longs, Ocimum tenuiflorum, Bacopa monnieri, Cuminum cyminum. **Chromatographic Separation of natural products:** • Gas chromatography and its application's		**15**

	• Liquid chromatography: HPLC and its applications, HPTLC for Separation and analysis of natural products.		
UNIT III Polymers	**Polymers:** • Introduction to polymers • Types of polymers- Monomer, polymer, • Homopolymer, copolymer, Thermoplastics • And Thermosets, Biodegradable polymers. **Nanomaterials:** • Introduction to Nanomaterials. • Forms of Nanomaterials: Nanoparticles, Nanofilms and Nanotubes • Synthesis and Characterization of Nanomaterials. • Applications of Nanomaterials.		**15**

SEMESTER-IV
Paper-III MEDICAL MICROBIOLOGY (UBT4MEM)

Course Objective: The objective of this course is to gain insight into Disease Factors and Processes and Diseases Caused by Microorganisms.
Learning Outcome: By the end of the course the student will be able to:
- List the factors playing a role in causing a disease.
- Discuss the various aspects of Systemic Infections including Causative Agents, Symptoms and Prophylaxis.
- Gain the technical capability of handling, isolating and identifying various Bacteria.

Unit	Title	Credits	Lectures
UNIT I Infectious Diseases	**Host Parasite Relationship:** • Normal Flora; Factors Affecting the Course of • Infection and Disease; Mechanisms of Infection and Virulence Factors. **Infection:** • Patterns of Infection; Types of Infections; Signs and Symptoms; Epidemiology and Epidemiological Markers. **Diseases:** • Origin of Pathogens; Vectors; Acquisition of Infection; Koch's Postulates.	**2**	**15**
UNIT II Medical Microbiology- Causative Organisms- I	**Skin :***S. aureus, S. pyogenes.* **Respiratory Tract Infections :** • *M. tuberculosis, S. pneumonia* (Characteristics, Transmission, Course of Infection, Lab Diagnosis, Management of TB, Prevention and Control, Immuno and Chemoprophylaxis, DOTS and MDR). **Urinary Tract Infections:** • *E. coli*: Characteristics, Virulence, Clinical disease, and *E. coli* Infections. *Proteus*.		**15**

UNIT III Medical Microbiology- Causative Organisms- II	**GI Tract Infections :** • *Salmonella and Shigella spps*. (Characteristics, Virulence- Pathogenesis and Immunity, Clinical Disease, Carriers Lab Diagnosis, Phage Typing Prophylaxis and Treatment). **Sexually Transmitted Diseases :** • Syphilis and Gonorrhoea. **Nosocomial Infections :** • *Pseudomonas aeruginosa*		**15**

SEMESTER-IV
Paper-IV ENVIRONMENTAL BIOTECHNOLOGY (UBT4ENB)

Course Objective: The objective of this course is to gain awareness about different Types of Environmental Pollution and Related Issues.
Learning Outcome: By the end of the course the student will be able to:
- Gain an understanding of the causes, types and control methods for Environmental Pollution.
- Application of different life forms in Environmental Remediation.

Unit	Title	Credits	Lectures
UNIT I Environmental Pollution	**Sources of Pollution** **Air Pollution:** • Types; Sources; Classification of Air Pollutants; Air Pollution Monitoring and • Control. **Water Pollution:** • Causes, Types and Classification; • Eutrophication; Assessment of Water Quality- • Pollutant Monitoring and Control; **Soil and Solid Waste Pollution:** • Characteristics of Wastes, Impacts of Solid • Waste on Health, Occupational Hazards and • Control. **Soil Erosion:** • Concept, Causes and Effects.	**2**	**15 Lectures**
UNIT II Global Environmental Problems and Issues	**Green House Effect:** • Factors Responsible for Green House Effect; • Green House Gases. • Global Warming; • Ozone Depletion; • Kyoto Protocol; • UV Radiation; Acid Rain.		**15 Lectures**
UNIT III Bioremediation	• Concept of Bioremediation. • Microorganisms in Bioremediation, • Mycoremediation and Phytoremediation. • Bioremediation Technologies. • Measuring Bioremediation in the Field.		**15 Lectures**

	• Bioaugmentation and Biostimulation. • Monitoring the Efficacy of Bioremediation.		

SEMESTER-IV
Paper-V BIOINFORMATICS and BIOSTATISTICS (UBT4BBI)

Course Objective: The objective of this course is learning and understanding basic concepts of Bioinformatics and Biostatistics.

Learning Outcome: By the end of the course the student will be able to:

- Gain an understanding of the basic concepts of Bioinformatics and Biostatistics.
- Understand the tools used in Bioinformatics.
- Apply the various Statistical Tools for Analysis of Biological Data.

Unit	Title	Credits	Lectures
UNIT I Introduction to Computers and Biological Databases	**Computer Basics:** • Organization of a Computer; I/O Units; Computer Memory; Processor; Binary Arithmetic, Architecture; Operating System. **Internet Basics:** • Connecting to the Internet, E-mail, FTP, www, Difference between www and Internet. **Biological Databases:** • Classification of Databases - Raw and Processed Databases; Primary (NCBI), Secondary (PIR) and Tertiary or Composite (KEGG) Databases; Structure and Sequence Databases. • Specialized Databases - Protein Pattern Databases; Protein Structure and Classification Databases (CATH/SCOP). **Genome Information Resources:** • DNA Sequence Databases Specialized Genomic Resources. • Protein Databases based on Composition, • Motifs and Patterns. **Protein Structure Visualization Software:** • RasMol, Cn3D, Jmol	**2**	**15 Lectures**
UNIT II BLAST and Sequence Alignment	**BLAST and Sequence Alignment:** • BLAST and its Types; Retrieving Sequence using BLAST. **Pairwise Alignment:** • Identity and Similarity; Global and Local Alignment; Pairwise Database Searching. **Multiple Sequence Alignment:** • Goal of Multiple Sequence Alignment; Computational Complexity; Manual		**15 Lectures**

	Methods; Simultaneous Methods; Progressive Methods; Databases of Multiple Alignment; Secondary Database Searching, MSA and Phylogenetic Trees.		
UNIT III Biostatistics	**Theory and Problems based on: Correlation analysis-** • Coefficient of correlation: Direct, Short-cut method, Spearman's Rank Correlation coefficient, Scatter Diagram **Theory and Problems based on: Regression analysis-** • Regression coefficients, Regression lines (Linear Regression X on Y and Yon X). **Steps in Testing Statistical Hypothesis** **Parametric Tests** • Z Test – Single Mean and Two Means, • t-Test – Single Mean, Paired and Unpaired; **Non-Parametric Tests**-Chi-Square Test.		**15 Lectures**

SEMESTER-IV
Paper-V MOLECULAR DIAGNOSTICS (UBT4MOD)

Course Objective: The objective of this course is learning and understanding Molecular Techniques and utilizing these techniques in Diagnosis.

Learning Outcome: By the end of the course the student will be able to:

- Gain an understanding of the basic Principles used in Molecular Diagnosis.
- Gain critical thinking and analytical skills to understand new Diagnostic Methods.
- Apply the knowledge and skills gained in the course should be useful in developing new Diagnostic Kits.

Unit	Title	Credits	Lectures
UNIT I Basics of Molecular Diagnostics	• Overview of Molecular Diagnostics **Characterization and analysis of Nucleic Acids and Proteins**: • Extraction, Isolation and Detection of DNA, • RNA and Proteins; Restriction Endonucleases and Restriction Enzyme Mapping. **Hybridization Techniques:** • Southern, Northern, Western and FISH; Markers, Probes and its Clinical Applications.	**2**	**15 Lectures**
UNIT II Nucleic Acid Amplification Methods	**Target amplification:** • PCR - General Principle; Components of a Typical PCR Reaction; Experimental Design; Primer Designing; Control of PCR Contamination and Mispriming; PCR Product Clean-up and Detection.		**15 Lectures**

	PCR Types: • Reverse Transcriptase and Real Time PCR. **Probe amplification:** • Ligase Chain Reaction		
UNIT III Molecular Biology based Diagnostics	**DNA Polymorphism and Identification:** • RFLP and Parentage Testing; • RFLP and Sickle-Cell Anaemia. **Molecular Diagnostics for Infectious Diseases** • Molecular Testing for Neisseria, Molecular Diagnosis for HIV-1; **Genetic Counselling and Molecular Diagnosis** • Genetic Testing- Need and Uses; genetic Counselling. **Ethical, Social and Legal Issues to Molecular Genetic Testing**		**15 Lectures**

SEMESTER-IV
Paper-VI ENTERPRENEURSHIP DEVELOPMENT (UBT4END)

Course Objective: To develop and systematically apply an Entrepreneurial way of thinking that will allow identification and creation of Business Opportunities.

Learning Outcome: By the end of the course the student will be able to:

- Develop an understanding of the systematic process and to select and screen a Business idea.
- Design strategies for successful implementation of ideas.
- Write a Business Plan.
- Understand different forms of Intellectual Property protection

Unit	Title	Credits	Lectures
UNIT I Introduction to Entre-preneurship Development	Concept of Entrepreneur; • Entrepreneurship; • Need and Importance; • Factors Influencing Entrepreneurship; • Essentials of a Successful Entrepreneur	**2**	**15 Lectures**
UNIT II Setting-up, Planning of an Enterprise and Bio business	**Setting-up of an Enterprise** • Location of Enterprise; Real Estate and Human Resource Planning, Financial Planning; Role of Government and Financial • Institutions in Entrepreneurship Development; Raising Money from Venture • Capitalists, Government Grants **Preparation of a Business Plan** **Innovation & entrepreneurship in Bio-business**		**15 Lectures**

	• Introduction and scope in Bio-entrepreneurship, types of bio-industries and competitive dynamics between the sub-industries of the bio sector		
UNIT III Intellectual Property Rights (IPR)	• What is Intellectual Property? • Types of IPR, Patents, Copyright, Trademarks, Trade secret, Geographical indications, Traditional knowledge and Protection of undisclosed information. • Registered (Industrial) design, Brand, Logo, Regulatory Affairs, Corporate Law, IPR generation and Protection. • Patenting Biotechnological Inventions.		**15 Lectures**

PRACTICALS

SEMESTER III		
Course Code	**Title**	**Credits**
UBT4PR1 (Practicals of UBT4BIC and UBT4APC)	1. Determination of Lactate Dehydrogenase (LDH) Activity in Blood Serum. 2. Determination of Total, LDL and HDL Cholesterol in Serum. 3. Organ Function Tests: Liver (SGPT, SGOT); Kidney (Urea from Serum). 4. Estimation of Uric acid and Creatinine in Urine. 5. Qualitative Detection of Ketone Body in Urine. 6. Isolation of Mitochondria and Demonstration of ETC using a Marker Enzyme. 7. Separation of Binary (Solid-Solid) Mixture (Min 4 Compounds). 8. Identification of Organic Compound of Known Chemical Type (Min 4 Compounds). 9. HPLC analysis and interpretation of any one secondary metabolite from plants 10. Analysis of essential oils from any plant source using GC. 11. HPTLC fingerprint analysis of any one medicinally important plant. 12. Chemical and Biological Synthesis of Silver Nanoparticles and its characterisation by UV- Vis Spectrophotometer.	**2**

UBT4PR2 **(**Practicals of UBT4MEM and UBT4ENB)	1. Identification of *S.aureus*-Isolation, Catalase, Coagulase Test. 2. Identification of *E.coli*-Isolation, Sugar Fermentations, IMViC. 3. Identification of *Salmonella*- Isolation, Sugar Fermentations, TSI Slant. 4. Identification of *Shigella*- Isolation, Sugar Fermentations, TSI Slant. 5. Identification of *Proteus*- Isolation, Sugar Fermentations, IMViC. 6. Identification of *Pseudomonas* - Isolation, Urease test, Oxidase Test, TSI Slant. 7. RPR Test (Kit Based). 8. Permanent Slide- *Mycobacterium*. 9. Biological Oxygen Demand (BOD). 10. Chemical Oxygen Demand (COD). 11. Isolation of Bacteria from Air by Gravity Sedimentation Method. 12. Most Probable Number (MPN) – Presumptive, Confirmed and Completed tests. 13. Bioremediation of metal. 14. Visit to STP / CETP	**2**
UBT4PR3 **(**Practicals of UBT4 BBI and UBT4 MOD)	1. Familiarization with NCBI, EMBL, DDBJ, PIR, KEGG Databases. 2. Use of NCBI BLAST Tool. 3. Pairwise and Multiple Sequence Alignment and Phylogeny. 4. Classification of Proteins using CATH/SCOP. 5. Visualization PDB Molecules using Rasmol/Raswin. 6. Handling and Calibration of Micropipette. 7. Isolation, Quantitative Analysis and AGE of Genomic DNA from Bacteria and Yeast. 8. Isolation and Detection of RNA from Bacteria and Yeast. 9. Restriction Enzyme Digestion. 10. RFLP- Kit Based. 11. Primer Designing through Open Online Source NCBI- BLAST. 12. DNA Amplification – PCR. 13. Problems based on Correlation and Regression analysis 14. Problems based on Parametric an Non-parametric tests	**2**

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