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UNIVERSITY OF MUMBAI

No. UG/212 of 2017-18

CIRCULAR:-

A reference is invited to the syllabi relating to the Bachelor of Science (B.Sc.) Programme **vide** this office Circular No.UG/132 of 2009, dated 4th May, 2009 and the Principals of the affiliated Colleges in Science are hereby informed that the recommendation made by Board of Studies in Biotechnology at its meeting held on 7th January, 2017, has been accepted by the Academic Council at its meeting held on 11th May, 2017 **vide** item No.4.234 and that in accordance therewith, the revised syllabus as per the (CBCS) of S.Y.B.Sc. Biotechnology (Sem -III & IV), which is available on the University's website (www.mu.ac.in) and that the same has been brought into force with effect from the academic year 2017-18, accordingly.

MUMBAI - 400 032
22nd August, 2017
To


(Dr.M.A.Khan)
REGISTRAR

The Principals of the affiliated Colleges in Science.

A.C/4.234/11/05/2017

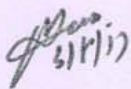
No. UG/212 -A of 2017

MUMBAI-400 032

22nd August, 2017

Copy forwarded with Compliments for information to:-

- 1) The Co-ordinator, Faculty of Science,
- 2) The Chairman, Board of Studies in Biotechnology,
- 3) The Offg. Director, Board of Examinations and Evaluation,
- 4) The Director, Board of Students Development,
- 5) The Co-Ordinator, University Computerization Centre,


(Dr.M.A.Khan)
REGISTRAR

....PTO

Academic Council: 2/2017

Item No:

UNIVERSITY OF MUMBAI



Syllabus for S.Y.B.Sc.

(Restructured)

Programme: B.Sc.

Course: Biotechnology

with effect from the Academic Year

2017 – 2018

SEMESTER- III				
Course code	Course type	Course Title	Credits	Lectures/ Week
USBT301	Core Subject	Biophysics	2	3
USBT302	Core Subject	Applied Chemistry- I	2	3
USBT303	Core Subject	Immunology	2	3
USBT304	Core Subject	Cell Biology and Cytogenetics	2	3
USBT305	Core Subject	Molecular Biology	2	3
USBT306	Skill Enhancement Elective	Bioprocess Technology	2	3
USBT307	General Elective	Research Methodology	2	3
USBTP301	Core Subject Practicals	Practicals of USBT_301 and USBT_302	2	6
USBTP302	Core Subject Practicals	Practicals of USBT_303 and USBT_304	2	6
USBTP303	Core Subject and Skill Enhancement Elective Practicals	Practicals of USBT_305 and USBT_306	2	6
SEMESTER-IV				
Course code	Course type	Course Title	Credits	Lectures/ Week
USBT401	Core Subject	Biochemistry	2	3
USBT402	Core Subject	Applied Chemistry- II	2	3
USBT403	Core Subject	Medical Microbiology	2	3
USBT404	Core Subject	Environmental Biotechnology	2	3
USBT405	Core Subject	Biostatistics and Bioinformatics	2	3
USBT406	Skill Enhancement Elective	Molecular Diagnostics	2	3
USBT407	General Elective	Entrepreneurship Development	2	3
USBTP401	Core Subject Practicals	Practicals of USBT_401 and USBT_402	2	6
USBTP402	Core Subject Practicals	Practicals of USBT_403 and USBT_404	2	6
USBTP403	Core Subject and Skill Enhancement Elective Practicals	Practicals of USBT_405 and USBT_406	2	6

SEMESTER III

Course Code	Title	Credits	No. of Lectures	Notional hours
USBT301	BIOPHYSICS	2		
<p>Course objectives:- The objective of this course is to have a firm foundation of the fundamentals and applications of current biophysical theories.</p> <p>Learning outcomes:- By the end of the course the student will:</p> <ul style="list-style-type: none"> • 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. 				
<p>UNIT I Optics and Electromagnetic Radiations</p>	<p>Introduction to Optics and Lasers: <i>Optics :</i> Properties of Light - Reflection, Refraction, Dispersion, Interference. <i>Lasers :</i> Properties of Lasers, Stimulated Emissions, Laser Action; Applications of Laser. Electromagnetic Radiations: Introduction to Electromagnetic Radiation. Spectroscopy : Types and Properties of Spectra; Basic Laws of Light Absorption. Spectrophotometer:-Principle, Instrumentation and Applications; UV-Vis Spectrophotometer, Single and Dual Beam Spectrophotometer. Microscopy: Types of Microscopy; Electron Optics; Electron Microscopy- Preparation of Specimen, SEM, TEM and Immuno-Electron Microscopy. Fluorescence Microscopy.</p>		15	
<p>UNIT II Heat, Sound, Magnetism and Fluid Dynamics</p>	<p>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. Magnetism: Magnetic Field; Magnetism of Earth; Paramagnetism, Diamagnetism, Ferromagnetism. Nuclear Magnetism and Biomagnetism.</p>		15	

	<p>Fluid Dynamics :</p> <p>Viscosity:</p> <p>Definition Flow of Liquids through Capillaries; Stokes' Law; Terminal Velocity. Determination of 'η' by Falling Sphere Method; Viscosity Estimation by Oswald's Viscometer.</p> <p>Surface Tension:</p> <p>Definition - Surface Tension and Surface Energy; Capillary Action; Angle of Contact; Wettability; Temperature Dependence of Surface Tension.</p> <p>Applications in Biology.</p>			
<p>UNIT III Electrophoretic Techniques</p>	<p>Electrophoresis:</p> <p>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.</p> <p>Applications in Biology.</p>		15	

Course Code	Title	Credits	No. of Lectures	Notional hours
USBT302	APPLIED CHEMISTRY –I	2		
<p>Course objectives:-</p> <p>The objective of this course is to have a firm foundation of the fundamentals and applications of Organic and Green Chemistry.</p> <p>Learning outcomes:- By the end of the course the student will be able to:</p> <ul style="list-style-type: none"> • 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. 				
<p>UNIT I Organic Chemistry</p>	<p>Introduction to Types of Organic Reactions :</p> <p>Addition, Elimination and Substitution Reactions.</p> <p>Essential and Non-essential Elements in Biological Systems.</p> <p>Role of Metal Ions in Biological Systems.</p> <p>Metal Coordination in Biological Systems :</p> <p>Enzymes, Apoenzymes and Coenzymes.</p> <p>Biological Role of Metalloenzymes <i>wrt</i> Myoglobins, Haemoglobin.</p> <p>Biological Role of Carboxypeptidases, Catalases and Peroxidases.</p>		15	

	Structure and Function : Dioxygen Binding, Transfer and Utilization; Metal Complexes in Medicines.			
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. Retrosynthesis.		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	

Course Code	Title	Credits	No. of lectures	Notional hours
USBT303	IMMUNOLOGY	2		
Course objectives:- The objective of this course is to familiarize students with the Immune Effector Mechanisms and various Immunotechniques.				
Learning outcomes:- By the end of the course the student will be able to:				
<ul style="list-style-type: none"> Understand the role of different types of Cells, Effector Molecules and Effector Mechanisms in Immunology. Understand the principles underlying various Immunotechniques. 				
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		15	
UNIT II Cell Receptors	T-cell Receptor Complex : Structure and Activation. MHC Classes - General Organization and Inheritance; Structures and Peptide Interactions; Class I and II Diversity and Polymorphism; Antigen Presentation - Endocytic and Exocytic Pathways; MHC Restriction. B-cell Receptor : Structure, Maturation and Activation B-T Cell Interaction (B-T cell Cooperation).		15	

UNIT III Immuno- Techniques	<p>Precipitation Reactions : Immunoprecipitation, Immuno-electrophoresis, CIEP, Rocket Electrophoresis and 2-D Immuno-electrophoresis.</p> <p>Agglutination Reactions : Passive, Reverse Passive, Agglutination Inhibition. Coomb's Test; Complement Fixation Tests, RIA, ELISA, ELISPOT, Chemiluminescence, Western Blot, Immunofluorescence, Flow Cytometry.</p> <p>Alternatives to Antigen-Antibody Reactions.</p>		15	
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Course Code	Title	Credits	No. of lectures	Notional hours
USBT304	CELL BIOLOGY AND CYTOGENETICS	2		

Course objectives:-

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

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

- Develop an understanding of the Cytoskeleton and Cell Membrane.
- Discuss the structure of Chromosomes and types of Chromosomal Aberrations.
- Discuss the principles underlying Sex Determination, Linkage and Mapping.

UNIT I Cytoskeleton	<p>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.</p>		15	
UNIT II Cell Membrane	<p>Cell Membrane : Uptake of Nutrients by Prokaryotic Cells; Cell Permeability. Principles of Membrane Transport-Transporters and Channels; Active Transport,</p>		15	

	<p>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.</p> <p>Cellular Interactions.</p>			
UNIT III Cytogenetics	<p>Cytogenetics : Structure of Chromosome - Heterochromatin, Euchromatin, Polytene Chromosomes.</p> <p>Variation in Chromosomal Structure and Number : Deletion, Duplication, Inversion, Translocation, Aneuploidy, Euploidy and Polyploidy and Syndromes- Klinefelter, Turner, Cri-du-Chat, Trisomy -21, Trisomy 18 and Trisomy 13.</p> <p>Sex Determination and Sex Linkage : Mechanisms of Sex Determination (XX-XY, ZZ-ZW, XX-XO) Dosage Compensation and Barr Body.</p> <p>Genetic Linkage, Crossing Over and Chromosomal Mapping : Tetrad Analysis; Two-point Cross; Three-point Cross; Pedigree Analysis.</p>		15	

Course Code	Title	Credits	No. of Lectures	Notional hours
USBT305	MOLECULAR BIOLOGY	2		
<p>Course objectives:- The objective of this course is to have an insight into mechanism of Gene Expression and Regulation.</p> <p>Learning outcomes:- By the end of the course the student will be able to:</p> <ul style="list-style-type: none"> • Discuss the mechanisms associated with Gene Expression at the level of Transcription and Translation. • Discuss the mechanisms associated with Regulation of Gene Expression in Prokaryotes and Eukaryotes 				
UNIT I Gene Expression- Transcription	<p>Gene Expression- an Overview.</p> <p>Transcription Process in Prokaryotes : RNA Synthesis; Promoters and Enhancers; Initiation of Transcription at Promoters; Elongation and Termination of an RNA Chain.</p> <p>Transcription in Eukaryotes : Eukaryotic RNA Polymerases; Eukaryotic Promoters; Transcription of Protein Coding Genes by RNA Polymerase; Eukaryotic mRNA's; Transcription of other genes;</p>		15	

	Spliceosomes; RNA editing.			
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.		15	
UNIT III Regulation of Gene Expression	In Prokaryotes: In Bacteria : <i>lac</i> Operon of <i>E.coli</i> ; <i>trp</i> Operon of <i>E.coli</i> . In Viruses : Lytic / Lysogenic Regulation In Eukaryotes : Operons in Eukaryotes; Control of Transcriptional Initiation; Gene Silencing and Genomic Imprinting; Post-Transcriptional Control; RNA Interference.		15	

Course Code	Title	Credits	No. of Lectures	Notional hours
USBT306	BIOPROCESS TECHNOLOGY	2		
Course objectives:- 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 outcomes:- By the end of the course the student will be able to:				
<ul style="list-style-type: none"> • Develop an understanding of the various aspects of Bioprocess Technology. • Develop skills associated with screening of Industrially Important Strains. • Understand principles underlying design of Fermentor and Fermentation Process. 				
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.		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.		15	

	<p>Process Parameters : pH, Temperature, Aeration, Agitation, Foam, etc.</p> <p>Types of Fermentation : Surface and Submerged; Batch and Continuous, Aerobic and Anaerobic.</p> <p>Product Isolation and Purification.</p> <p>Study of Representative Fermentation Processes : Outline of Penicillin and Ethanol Production by Fermentation along with a <i>flow-diagram</i>.</p>			
<p>UNIT III <i>In-vivo and In-vitro</i> Assay of Industrial Products</p>	<p>Assay of Industrial Products: Chemical and Biological; Types and Subtypes; Kinetics. Advantages and Disadvantages. Half-Life Determination of Pharmacological Products. Bioavailability and Bioequivalence Studies</p>		15	

Course Code	Title	Credits	No. of Lectures	Notional hours
USBT307	RESEARCH METHODOLOGY	2		
<p>Course objectives:- The objective of this course is to develop Research Aptitude, Logical Thinking and Reasoning.</p> <p>Learning outcomes:- By the end of the course the student will be able to:</p> <ul style="list-style-type: none"> • Understand basic principles of Research Methodology and identify a Research Problem. • Understand a general definition of Research Design. • Identify the overall Process of Designing a Research Study from its inception to its Report. 				
<p>UNIT I Introduction to Research Methodology and Research Problem</p>	<p>Meaning of Research; Objectives of Research; Motivation in Research; Types of Research; Research Approaches; Significance of Research; Research Methods versus Methodology; Research Process; Criteria of Good Research; Problems Encountered by Researchers in India; What is a Research Problem? Selecting the Problem; Necessity of Defining the Problem; Technique Involved in Defining a Problem</p>		15	
<p>UNIT II Research Design and Data Collection</p>	<p>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; Developing a Research Plan- Collection of Primary Data; Observation Method; Interview Method; Collection of Data</p>		15	

	through Questionnaires; Collection of Data through Schedules; Other Methods of Data Collection, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Case Study Method			
UNIT III 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, Mechanics of Writing a Research Report, Precautions for Writing Research Reports.		15	
Internal Evaluation	Submission of Research Report/ Project/ Case Study/ Assignment			

PRACTICALS

SEMESTER III		
Course code	Title	Credits
USBTP301 (PRACTICALS based on USBT301 and USBT302)	<ol style="list-style-type: none"> 1. Study of Absorption Spectra of Coloured Compounds (CuSO₄, CoCl₂, KMnO₄). 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 : <ol style="list-style-type: none"> a) Acetylation of Primary Amine (Preparation of Acetanilide). b) Base Catalysed Aldol Condensation (Synthesis of Dibenzalpropanone). 	2
Course code	Title	Credits
USBTP302 (PRACTICALS based on USBT303 and USBT304)	<ol style="list-style-type: none"> 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. 8. Study of Chromosomal Aberrations- Deletion, Duplication, Inversion, 	2

	<p>Translocation and Syndromes- Trisomy 21 Trisomy 13 Trisomy 18, Klinefelter, Turner and Cri-du-Chat.</p> <p>9. Induction of Polyploidy by PDB Treatment using Suitable Plant Material.</p> <p>10. Study of Polytene Chromosomes.</p> <p>11. Mapping based on Tetrad Analysis and Three Point Cross.</p> <p>12. Pedigree Analysis- Autosomal and Sex-Linked.</p>	
Course code	Title	Credits
<p>USBTP303 (PRACTICALS based on USBT305 and USBT306)</p>	<ol style="list-style-type: none"> 1. Study of <i>E.coli</i> Diauxic Growth Curve- (Lactose and Glucose). 2. Study of <i>lac</i> 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 <i>Penicillin</i> from Broth Culture of <i>Penicillium spp.</i> by Solvent Extraction. 8. Lab Scale Production of Ethanol. 9. Purification of Ethanol from Broth Culture of <i>Saccharomyces spp.</i> by Distillation. 10. Estimation of <i>Penicillin</i> from Recovered Broth by Chemical (Iodometric) Method. 11. Estimation of <i>Penicillin</i> from Recovered Broth by Biological (Bioassay) Method. 12. Estimation of Alcohol from Recovered Broth by Dichromate Method. 	<p>2</p>

SEMESTER-IV

Course Code	Title	Credits	No. of Lectures	Notional hours
USBT401	BIOCHEMISTRY	2		
<p>Course objectives:- The objective of this course is to gain an insight into the Metabolic Processes associated with Catabolism of Carbohydrates, Amino Acids, Lipids and Nucleotides.</p> <p>Learning outcomes:- By the end of the course the student will be able to</p> <ul style="list-style-type: none"> • Discuss the Metabolic Pathways of Carbohydrates, Amino Acids, Lipids and Nucleotides. • Explain the Role of Energy Rich Molecules in Metabolism. 				
<p>UNIT I Carbohydrate Metabolism, ETS and Energy Rich Compounds</p>	<p>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)</p> <p>Electron Transport System : Electron Transport and Oxidative Phosphorylation. Inhibitors of ETS.</p> <p>Energy Rich Compounds : ATP as Energy Currency, Structure of ATP, Hydrolysis, Other Energy Rich Compounds other than ATP like PEP, Creatine Phosphate, etc.</p>	15	15	
<p>UNIT II Amino Acid Metabolism</p>	<p>Amino Acid Breakdown : Deamination, Transamination, Urea Cycle, Breakdown of Glucogenic and Ketogenic Amino Acids.</p> <p>Amino Acids as Biosynthetic Precursors : Biosynthesis of Epinephrine, Dopamine, Serotonin, GABA, Histamine, Glutathione. (Sequence of Reactions, Regulation and Metabolic Disorders of the above Pathways)</p>	15	15	
<p>UNIT III Lipid and Nucleotide Metabolism</p>	<p>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. (Sequence of Reactions, Regulation, Energy Yield and Metabolic Disorders of the above Pathways)</p>	15	15	

	Nucleotide Metabolism : Degradation of Purines and Pyrimidines.			
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Course Code	Title	Credits	No. of Lectures	Notional hours
USBT402	APPLIED CHEMISTRY –II	2		

Course objectives:-

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 outcomes:- By the end of the course the student will:

- 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 I Sampling and Separation Techniques	<p>Sampling : Importance of Sampling and Sampling Techniques Types of Sampling - Random and Non-Random Sampling of Solids, Liquids and Gases.</p> <p>Separation Techniques : Types of Separation Techniques - Filtration, Zone Refining, Distillation, Vacuum Distillation. Solvent Extraction - Partition Coefficient and Distribution Ratio, Extraction Efficiency, Separation Factor, Role of Complexing Agents, Chelation, Ion Pair Formation, Solvation, and Soxhlation. Centrifugation - Basic Principles of Sedimentation.</p>	15	15	
UNIT II Natural Product Chemistry	<p>Natural Product Chemistry : Primary and Secondary Metabolites. Classification of Natural Products based on Bio-Synthesis. Classification of Natural Products based on Structure- Alkaloids, Phenolics, Essential Oils and Steroids. Structure Determination of Natural Products. Commercial Synthesis of Natural Products.</p> <p>Chromatographic Separation of Natural Products : Gas Chromatography and its Applications. Liquid Chromatography : HPLC and its Applications. HPTLC for Separation and Analysis of Natural Products.</p>	15	15	

UNIT III Polymers and Nanomaterials	Polymers : Introduction to Polymers. Types of Polymers - Monomer, Polymer, Homopolymer, Copolymer, Thermoplastics and Thermosets, Addition and Condensation Polymers (Examples and Uses) Stereochemistry of Polymers. Biodegradable Polymers. Nanomaterials : Introduction to Nanomaterials. Forms of Nanomaterials : Nanoparticles, Nanofilms and Nanotubes Synthesis and Characterization of Nanomaterials. Applications of Nanomaterials.	15	15	
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Course Code	Title	Credits	No. of lectures	Notional hours
USBT403	MEDICAL MICROBIOLOGY	2		
Course objectives:- The objective of this course is to gain insight into Disease Factors and Processes and Diseases Caused by Microorganisms. Learning outcomes:- By the end of the course the student will be able to: <ul style="list-style-type: none"> • 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 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.		15	
UNIT II Medical Microbiology- Causative Organisms- I	Skin : <i>S. aureus, S. pyogenes.</i> Respiratory Tract Infections : <i>M. tuberculosis, S. pneumoniae</i> (Characteristics Transmission, Course of Infection, Lab Diagnosis, Management of TB, Prevention and Control, Immuno and Chemoprophylaxis, DOTS and MDR).		15	

	Urinary Tract Infections : <i>E.coli</i> : Characteristics, Virulence, Clinical disease, and <i>E.coli</i> Infections. <i>Proteus</i> .			
UNIT III Medical Microbiology - Causative Organisms- II	GI Tract Infections : <i>Salmonella and Shigella spp.</i> (Characteristics, Virulence- Pathogenesis and Immunity, Clinical Disease, Carriers Lab Diagnosis, Phage Typing Prophylaxis and Treatment). Sexually Transmitted Diseases : Syphilis and Gonorrhoea. Nosocomial Infections : <i>Ps. aeruginosa</i>		15	

Course Code	Title	Credits	No. of Lectures	Notional hours
USBT404	ENVIRONMENTAL BIOTECHNOLOGY	2		
Course objectives:- The objective of this course is to gain awareness about different Types of Environmental Pollution and Related Issues. Learning outcomes:- By the end of the course the student will be able to: <ul style="list-style-type: none"> Gain an understanding of the causes, types and control methods for Environmental Pollution. Application of different life forms in Environmental Remediation. 				
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.		15	
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	

UNIT III Bioremediation	<p>Concept of Bioremediation.</p> <p>Microorganisms in Bioremediation, Myco-remediation and Phytoremediation.</p> <p>Bioremediation Technologies.</p> <p>Measuring Bioremediation in the Field.</p> <p>Bioaugmentation and Biostimulation.</p> <p>Monitoring the Efficacy of Bioremediation.</p>		15	
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Course Code	Title	Credits	No. of Lectures	Notional hours
USBT405	BIOINFORMATICS and BIOSTATISTICS	2		

Course objectives:-

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

Learning outcomes:- 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 I Introduction to Computers and Biological Databases	<p>Computer Basics :</p> <p>Organization of a Computer; I/O Units; Computer Memory; Processor; Binary Arithmetic; Logic Circuit; Architecture; Operating System.</p> <p>Internet Basics :</p> <p>Connecting to the Internet, E-mail, FTP, www, Difference between www and Internet.</p> <p>Biological Databases :</p> <p>Classification of Databases - Raw and Processed Databases; Primary (NCBI), Secondary (PIR) and Tertiary or Composite (KEGG) Databases; Structure and Sequence Databases.</p> <p>Specialized Databases - Protein Pattern Databases; Protein Structure and Classification Databases (CATH/SCOP).</p> <p>Genome Information Resources:</p> <p>DNA Sequence Databases Specialized Genomic Resources.</p> <p>Protein Databases based on Composition, Motifs and Patterns.</p> <p>Protein Structure Visualization Software.</p>		15	
UNIT II BLAST and Sequence Alignment	<p>BLAST and Sequence Alignment :</p> <p>BLAST and its Types; Retrieving Sequence using BLAST.</p> <p>Pairwise Alignment :</p> <p>Identity and Similarity; Global and Local Alignment; Pairwise Database Searching.</p>		15	

	Multiple Sequence Alignment: Goal of Multiple Sequence Alignment; Computational Complexity; Manual Methods; Simultaneous Methods; Progressive Methods; Databases of Multiple Alignment; Secondary Database Searching; Analysis Packages; MSA and Phylogenetic Trees.			
UNIT III Biostatistics	Theory and Problems based on- Coefficient of Correlation and Regression Analysis; Steps in Testing Statistical Hypothesis; Parametric Tests:- Z Test – Single Mean and Two Means, t-Test – Single Mean, Paired and Unpaired; Chi-Square Test.		15	

Course Code	Title	Credits	No. of Lectures	Notional hours
USBT406	MOLECULAR DIAGNOSTICS	2		
<p>Course objectives:- The objective of this course is learning and understanding Molecular Techniques and utilizing these techniques in Diagnosis.</p> <p>Learning outcomes:- By the end of the course the student will be able to:</p> <ul style="list-style-type: none"> • 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 I Basics of Molecular Diagnostics	<p>Introduction to Molecular Diagnostics : Overview of Molecular Diagnostics; History of Molecular Diagnostics; Molecular Diagnostics in Post Genomic Era; Areas used in Molecular Diagnostics; Future Prospects - Commercialising Molecular Diagnostics, Personalized Medicine, Theranostics.</p> <p>Characterisation and analysis of Nucleic – Acids and Proteins : Extraction, Isolation and Detection of DNA, RNA and Proteins; Restriction Endonucleases and Restriction Enzyme Mapping.</p> <p>Hybridisation Techniques : Southern, Northern, Western and FISH; Markers, Probes and its Clinical Applications.</p>		15	
UNIT II Nucleic Acid Amplification Methods	<p>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.</p> <p>PCR Types : Reverse Transcriptase and Real Time PCR.</p>		15	

	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 <i>Neisseria</i> , Molecular Diagnosis for HIV-1; Genetic Counselling and Molecular Diagnosis Genetic Testing- Need and Uses; genetic Counselling. Case Studies- Diagnostic Testing for Cystic Fibrosis; Fragile X Diagnostic and Carrier Testing. Ethical, Social and Legal Issues to Molecular - Genetic Testing		15	

Course Code	Title	Credits	No. of Lectures	Notional hours
USBT407	ENTERPRENEURSHIP DEVELOPMENT	2		
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:				
<ul style="list-style-type: none"> • 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. 				
UNIT I Introduction to Entrepreneurship Development	Concept of Entrepreneur; Entrepreneurship; Need and Importance; Factors Influencing Entrepreneurship; Essentials of a Successful Entrepreneur		15	
UNIT II Setting-up of an Enterprise and Planning	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, Product Selection and Ideas; Project Planning and Formulation; Project Feasibility Assessment; Regulatory Affairs, Corporate Laws, Innovation, IPR generation and Protection, Preparation of a Business Plan, Characteristics and Importance of Planning;		15	

UNIT III Marketing, Sales, Advertising and International Market research	Marketing Plan for an Entrepreneur; Strategic Alliances, Advertising and Sales Promotion; Market Assessment, Need for International Market Research, Domestic vs. International Market Research, Cost and Methodology of Market Research, Desk and Field Research		15	
Internal Evaluation	Submission and Presentation of Business Proposal for any Biotechnological Product/ Enterprise			

SEMESTER IV		
Course code	Title	Credits
USBTP401 (PRACTICALS based on USBT401 and USBT402)	<ol style="list-style-type: none"> 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
Course code	Title	Credits
USBTP402 (PRACTICALS based on USBT403 and USBT404)	<ol style="list-style-type: none"> 1. Identification of <i>S.aureus</i>-Isolation, Catalase, Coagulase Test. 2. Identification of <i>E.coli</i>-Isolation, Sugar Fermentations, IMViC. 3. Identification of <i>Salmonella</i>- Isolation, Sugar Fermentations, TSI Slant. 4. Identification of <i>Shigella</i>- Isolation, Sugar Fermentations, TSI Slant. 5. Identification of <i>Proteus</i>- Isolation, Sugar Fermentations, IMViC. 6. Identification of <i>Pseudomonas</i> - Isolation, Urease test, Oxidase Test, TSI Slant. 7. RPR Test (Kit Based). 8. Permanent Slide- <i>Mycobacterium</i>. 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. 	2

	13. Bioremediation of Metal. 14. Visit to STP / CETP	
Course code	Title	Credits
USBTP403 (PRACTICALS based on USBT405 and USBT406)	<ol style="list-style-type: none"> 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. 	2

Summer Training:

1. This should be taken up in the summer over a period of one month preferably in an Immunology / Veterinary / Virology Institute or a laboratory using Recombinant DNA Methods.
2. The students could also be assigned to assist a Clinic (in a hospital), a Fermentation Plant, Brewery or Bakery and watch the various stages in Brewing and Baking and Post-Fermentation Processing. Prior arrangement must be made on the mode of interaction of the educational institute with the Clinic and the Industry.

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EVALUATION PATTERN

The performance of the learner shall be evaluated in TWO parts.

The learner's Performance shall be assessed by Internal Assessment of 25 Marks and Semester End Examination (Theory) of 75 marks for each Term.

Practical Examination will be conducted at end of each Semester for 300 marks

Internal Assessment- 25 Marks

SR. No.	Particulars	Marks
1.	Class test Objective Type Questions(10) Concept Based Questions-Answer in one/two sentences (5) Short Notes-answer any Two out of Three	5 Marks 5 Marks 10 Marks
2.	Department Activities, Attendance etc.	5 Marks
	TOTAL	25 Marks

Internal Assessment – 25 Marks (General Elective each Semester)

For Course Code USBT 307 (Research Methodology) and USBT 407 (Entrepreneurship Development)

SR. No.	Particulars	Marks
1.	Submission as per instructed in theory Course Code USBT 307 and USBT 40	20 Marks
2.	Department Activities, Attendance etc.	5 Marks
	TOTAL	25 Marks

Semester end Exam- 75 marks

SR. No.	Particulars	Marks
All questions are Compulsory Number Questions : 5 (Five) Each Question carries 15 Marks		
1.	Q 1 – Objective Questions based on unit I, II, III (Internal Options)	15 Marks
2.	Q 2 – Unit I	15 Marks
3.	Q 3 – Unit II	15 Marks
4.	Q 4 – Unit III	15 Marks
5.	Q 5 – Short Notes based on Unit I, II, III (Any 3 out of 5)	15 Marks
	TOTAL	75 Marks

Note:-

- All questions are compulsory with internal options within the questions.
- Each question may be sub-divided into sub questions as a, b, c, d, e etc. & the allocation of marks depends on the weightage of the topic.

Practical examination – 300 marks

SEMESTER III

USBTP301	Core Subject Practicals	Practicals of USBT301 and USBT302	100 Marks
USBTP302	Core subject Practicals	Practicals of USBT303 and USBT304	100 Marks
USBTP303	Core Subject and Skill Enhancement Elective Practicals	Practicals of USBT305 and USBT306	100 Marks

SEMESTER IV

USBTP301	Core Subject Practicals	Practicals of USBT301 and USBT302	100 Marks
USBTP302	Core Subject Practicals	Practicals of USBT303 and USBT304	100 Marks
USBTP303	Core Subject and Skill Enhancement Elective Practicals	Practicals of USBT305 and USBT306	100 Marks