

Deccan Education Society's

Kirti M. Doongursee College of
Arts, Science and Commerce
(AUTONOMOUS)



Affiliated to

UNIVERSITY OF MUMBAI

Syllabus for
Program: Bachelor of Science
Biotechnology:
with effect from

Academic Year 2022-2023

Semester I

Course Code	Course Title	Credits	Lectures /Week
KUSBT22101	Paper I Fundamentals of biotechnology-1	2	3
About the Course:			
Course Objectives:			
<ul style="list-style-type: none"> To acquaint students with various fields of Biotechnology and their applications 			
Learning Outcomes:			
After successful completion of this course, students would be able to			
<ul style="list-style-type: none"> To impart the knowledge of Food Technology and Fermentation Techniques 			
Unit	Topics	No of Lectures	
I Scope and introduction to biotechnology	<p>Biotechnology –an interdisciplinary biological science; Biotechnology – definition; History & Introduction to Biotechnology; Traditional and Modern Biotechnology;</p> <p>Scope and importance of biotechnology; World of Biotechnology- Pharmaceutical Biotechnology, Plant Biotechnology, Industrial Biotechnology, Marine Biotechnology, Animal Biotechnology, Medical biotechnology, Environmental Biotechnology.</p> <p>Biotechnology in India – bio-business in India, booming biotech market, success story of biotech market, policy initiatives; and global trends;</p> <p>Biotechnology research in India;</p> <p>Potential of modern biotechnology;</p> <p>Achievement of biotechnology; Prevention of misuse of biotechnology;</p> <p>Biotechnology Institutions in India (Public and Private Sector);</p> <p>Public Perception of Biotechnology.</p> <p>Case study: Serum Institute of India and its products</p>	15	
II Application	1. Agriculture –GM fruits- GM papaya, GM tomato	15	

<p>s of Biotechnology</p>	<p>Insect resistant transgenic plants – Bt cotton, Bt brinjal</p> <p>Modifications in nutrient quality – starch, oil, seed protein, golden rice</p> <p>2. Livestock – growth, disease resistance, product quality, pharmaceuticals and nutritional supplements, industrial applications</p> <p>3. Human welfare Cloned genes for production of -Insulin; recombinant vaccine for Hepatitis B virus.</p> <p>Molecular farming</p> <p>Edible vaccines and their advantages</p> <p>4. Environment- pollution abatement through GMOs</p> <p>Bioethics</p> <p>Case study: Genetically modified microbes for bioremediation of oil spills in marine environment</p>	
<p>III Fermentation on technology</p>	<p>Introduction</p> <p>Introduction to fermentation processes Microbial biomass, Microbial enzymes, Microbial metabolites, recombinant products, transformation processes Development of fermentation Industry Component Parts of fermentation process</p> <p>Screening: Definition Primary screening and its methods Secondary screening and its methods</p> <p>Fermenter design: Definition of a fermentor Aerated stirred tank batch fermentor-Typical design Construction materials used, aeration and agitation Temperature control Foam production and control pH measurement and control CO₂ and O₂ control</p> <p>Fermentation medium: Basic requirements of industrial media Criteria for use of raw materials in media Examples of raw materials used Growth factors Water Carbohydrate sources Protein sources</p> <p>Product- a typical process of Ethanol production and Antibiotic production</p>	<p>15</p>
<p>Textbooks:</p> <ol style="list-style-type: none"> 1. A Textbook of Biotechnology by R Chaubey 4th edition 2. Advanced Biotechnology by R C Dubey 1st edition 		

3. Biotechnology, Expanding Horizons by B D Singh, 4th edition

Additional References:

1. Stanbury and whitaker 3rd ed
2. Screening- Casida
3. Fermenter Design- Nduka Okafor 1sted

Course Code	Course Title	Credits	Lectures /Week
KUSBT22102	Paper II-Microbiology-1	2	3
About the Course:			
Course Objectives:			
<ul style="list-style-type: none"> To acquaint students with basic techniques in Staining and Sterilization 			
Learning Outcomes:			
After successful completion of this course, students would be able to			
<ul style="list-style-type: none"> To impart the knowledge of growth of microorganisms. 			
Unit	Topics	No of Lectures	
I Introduction to microbiology	<p>Fundamentals, History and Evolution of Microbiology. Discovery of Microorganisms, Conflict over spontaneous generation. Role of microorganisms in disease</p> <p>Classification: The place of Microorganisms in the living world Classification whittaker's five kingdom classification Introduction to Bergey's Manual Groups of Microorganisms Applications of microbiology in various fields</p> <p>Cultivation and Maintenance of microorganisms,Nutritional categories of microorganisms, methods of isolation.</p>	15	
II Sterilization techniques	<p>Definition : Sterilization and Disinfection. Types and Applications Dry Heat, Steam under pressure Gases, Radiation and Filtration Chemical Agents and their Mode of Action - Aldehydes, Halogens, Quaternary Ammonium Compounds, Phenol and Phenolic Compounds, Heavy Metals, Alcohol, Dyes, and Detergents</p>	15	

	Ideal Disinfectant. Examples of Disinfectants and Evaluation of Disinfectant	
<p style="text-align: center;">III Microscopy and stains</p>	<p>Microscope- Simple and Compound: General principles of optics; various parts and their functions - objectives – numerical aperture, resolving power, depth of focus, working distance, aberrations; oculars; condensers. Dark Field Microscope; Phase Contrast Microscope and Fluorescent Microscope, TEM, SEM</p> <p>Applications of microscopes</p> <p>Stains and Staining Solutions</p> <p>Definition of Dye and Chromogen; acidic and basic dyes; functions and types of chromophore and auxochrome groups. Theories to explain staining. Definition and function of stain; mordant, intensifiers and fixative.</p> <p>Natural and Synthetic Dyes.</p> <p>Simple Staining, Differential Staining – Gram staining and Acid Fast Staining with specific examples</p>	<p>15</p>
<p>Textbooks:</p> <p>1 Microbiology by Prescott 5th edition 2 Microbiology by Pelczar, Reid and Chan 5th Edition 3 Textbook of Microbiology by Ananthanarayan</p> <p>Additional References:</p> <p>1. Fundamental Principles of Bacteriology A J Salle 7th 2. Microbiology by Pelczar, Chan and Krieg, 5th Ed</p>		

Course Code	Course Title	Credits	Lectures /Week
KUSBT22103	Paper III Basic Chemistry-1	2	3
About the Course:			
Course Objectives:			
<ul style="list-style-type: none"> To acquaint students with Concepts of Stereochemistry 			
Learning Outcomes:			
After successful completion of this course, students would be able to			
<ul style="list-style-type: none"> To impart knowledge of Titrimetric and Volumetric Estimations and handling of basic Analytical Techniques like Chromatography and Colorimetry 			
Unit	Topics	No of Lectures	
I Nomenclature and Chemical bonds	<p>Classification and Systematic Nomenclature of organic compounds.</p> <p>Chemical Bonds: Types and transition between the main types of bonding.</p> <p>Ionic Bond: Nature of Ionic Bond, factors influencing the formation of Ionic Bond. Structure of NaCl and CsCl.</p> <p>Covalent Bond: Nature of Covalent Bond, Types of covalent bond (Polar and Coordinate covalent bonds). Structure of CH₄, NH₃, H₂O, Shapes of BeCl₂, BF₃.</p> <p>Hydrogen Bond: Theory of Hydrogen Bonding and Types of Hydrogen Bonding (with examples of RCOOH, ROH, Salicylaldehyde, Amides and Polyamides).</p>	15	
II Titrimetry and gravimetry	<p>Titrimetric Analysis: Titration, Titrant, Titrand, End Point, Equivalence Point, Titration Error, Indicator, Primary and Secondary Standards, Characteristics and examples.</p> <p>Types of Titration – Acid –Base, Redox. Precipitation, Complexometric Titration. Acid – Base Titration - Strong Acid Vs Strong Base. Theoretical aspects of Titration Curve and End Point Evaluation.</p>	15	

	<p>Theory of Acid –Base Indicators, Choice and Suitability of Indicators.</p> <p>Gravimetric Analysis: Solubility and Precipitation, Factors affecting Solubility, Nucleation, Particle Size, Crystal Growth, Colloidal State, Ageing/Digestion of Precipitate.</p> <p>Co-Precipitation and Post-Precipitation. Washing, Drying and Ignition of Precipitate. (Numericals Expected).</p>	
III Stereochemistry	<p>Isomerism – Types of Isomerism: Constitutional Isomerism (Chain, Position and Functional) and Stereoisomerism, Chirality.</p> <p>Geometric Isomerism and Optical Isomerism: Enantiomers, Diastereomers, and Racemic mixtures Cis-Trans, Threo, Erythro and Meso isomers. Diastereomerism (Cis-Trans Isomerism) in Alkenes and Cycloalkanes (3 and 4 membered ring)</p> <p>Conformation: Conformations of Ethane. Difference between Configuration and Conformation.</p> <p>Configuration: Asymmetric Carbon Atom, Stereogenic/ Chiral Centers, Chirality Representation of Configuration by –Flying Wedge Formula</p> <p>Projection formulae – Fischer, Newman and Sawhorse. The Interconversion of the Formulae.</p>	15
<p>Textbooks:</p> <ol style="list-style-type: none"> 1. A Textbook of Organic Chemistry, 15th edition, Arun Bahl, B S Bahl, S. Chand 2. Vogel's Textbook of Quantitative Analysis, Fifth Edition 3. Organic Chemistry, by Solomon and Fryhle <p>Additional References:</p> <ol style="list-style-type: none"> 1. 2. 3. 		

Course Code	Course Title	Credits	Lectures /Week
KUSBT22104	Paper IV Biochemistry: Concept of Biomolecules-1	2	3
About the Course:			

Course Objectives:

- To acquaint the students with basic concepts of Chemistry like Classification and Nomenclature of Chemical compounds
- To acquaint students with Bioorganic Molecules

Learning Outcomes:

After successful completion of this course, students would be able to

- To impart hands-on skills in preparation of Buffers and Solutions
- To impart the knowledge of Classification, Structure and Characterization of Biomolecules

Unit	Topics	No of Lectures
I Water, Standard solutions and Buffers	Structure, Properties and functions of water Preparation of standard Solutions: Concept and significance of Chemical and Biological solutions. Normality, Molarity, Molality, Mole fraction, Mole concept, Solubility, Weight ratio, Volume ratio, Weight to Volume ratio, ppb, ppm, millimoles, milliequivalents (Numericals expected). Primary and Secondary Standards: Preparation of Standard Solutions Principle of Volumetric Analysis. Acids and Bases: Lowry-Bronsted and Lewis Concepts. Strong and Weak Acids and Bases - Ionic Product of Water - pH, pKa, pKb. Hydrolysis of Salts. Do one revision lec on Concept of pH	15

	<p>Buffer solutions –Concept of Buffers, Derivation of Henderson Hasselbalch equation for Acidic and Basic buffers Buffering capacity</p> <p>Biological buffers:</p> <p>Significance of biological buffers. pH of body fluids like blood and saliva. Blood buffer systems: Eg : Carbonate, Acetate and Phosphate buffers. (components, eg of buffers at various pH of cellular significance ; explain using Numericals) protein buffers -Introduction Significance of TRIS buffers - Introduction</p>	
<p>II Basics of Carbohydrate Chemistry</p>	<p>Carbohydrates: Introduction definition and general formula. Classification of carbohydrates - Monosaccharides - Two Families of Monosaccharides. Aldo series and keto series; (Triose - Glyceraldehyde and Dihydroxyacetone, Tetrose- Erythrose and Erythrulose, Pentose- Xylose, Xylulose, Ribose, Ribulose, Hexose- Glucose, Galactose, Mannose, Heptose- sedoheptose and Sedoheptulose structures to be taught) Concept of Enantiomers, Mutarotation, Anomeric carbon and Epimers of glucose.</p> <p>Biologically important Derivatives of Hexoses : Glucosamine, Gluconic acid, uronic acid, NAGA, NAMA (structures not to be expected in exams)</p> <p>Chemical reactions of monosaccharides</p> <p>Concept of glycosidic bond.</p> <p>Disaccharides- Maltose, Lactose, Sucrose, Cellobiose (structures to be taught, Biological significance, structure and bond type)</p>	<p>15</p>

	<p>Polysaccharides- Homopolysaccharides and Heteropolysaccharides; Structural and Storage Polysaccharides.</p> <p>Eg of polysaccharides -: starch (amylose and amylopectin), Glycogen, Peptidoglycan, Cellulose, chitin, (structure and bond type) Egs of Reducing and nonreducing carbohydrates.</p> <p>Industrial applications of carbohydrates: Fermentation, Pharmaceutical and Food industry.</p>	
<p style="text-align: center;">III Basics of Lipid Chemistry</p>	<p>Introduction to Lipid Chemistry. Definition and Biological functions of fats and Lipids. Definition of Fatty acids. Classification of Fatty acids- Saturated Fatty Acids : C2- C20 (Examples with trivial name, Biochemical names and Structures)</p> <p>Unsaturated Fatty Acids : Definition of MUFA and PUFA. C16- C20. Palmitolic, Oleic, Linoleic, Lenolenic, Arachidonic acid (Structures expected)</p> <p>Storage Lipids: AcylGlycerols (Simple and Mixed) Mono, Di and Triacylglycerols. (Structures expected)</p> <p>Properties of Triacylglycerols: Hydrolysis, Saponification, Antioxidant, Rancidity, Acid number, RM number Action of lipase.</p> <p>Structural lipids: Phosphatidic acid and Membrane Phospholipids Eg: Phosphatidylethanolamine, Phosphatidylserine, PhosphatidylCholine, Cardioliipin</p> <p>Action of Phospholipase.</p> <p>Steroid: Definition and functions Eg: Cholesterol</p>	<p>15</p>
<p>Textbooks:</p> <ol style="list-style-type: none"> 1. Robert Murray, Daryl G., Peter M.,Victor R.;Harper’s Illustrated Biochemistry. 2. Satyanarayana U. and Chakrapani U. (2007). Biochemistry. 3rd Edition. Books and Allied (P) Ltd. 3. Leininger PRINCIPLES OF BIOCHEMISTRY by Nelson and Cox Fifth Edition <p>Additional References:</p>		

1.
2.
3.

Course Code	Course Title	Credits	Lectures /Week
KUSBT22105	Paper V Genetics	2	3
About the Course:			
Course Objectives:			
<ul style="list-style-type: none"> To acquaint students with concepts in Genetics 			
Learning Outcomes:			
After successful completion of this course, students would be able to <ul style="list-style-type: none"> To impart skills in Techniques in Genetic Analysis and Population Genetics 			
Unit			
Unit		Topics	
No of Lectures			
I	Genetics fundamentals	Introduction to genetic and sub-disciplines of genetics: Transmission genetics, Molecular genetics, Population genetics and Quantitative genetics. Basic Terminologies in genetics Mendelian Genetics: Monohybrid Crosses and Mendel's Principle of Segregation. Representing crosses with a Branch Diagram. Confirming the principle of Segregation: The use of Test crosses. Dihybrid crosses and Mendel's Principle of Independent Assortment.	15

	<p>Extensions of and Deviations from Mendelian Genetic Principles: Multiple Alleles - ABO Blood groups Modifications of Dominance Relationships: Incomplete Dominance and Codominance. Essential Genes and Lethal Alleles. Effects of the environment on Gene expression. Gene Interactions and Modified Mendelian Ratios: Epistatic and non-epistatic interactions.</p> <p>Mendelian Genetics in Humans: Pedigree Analysis. Examples of Human Genetic Traits</p>	
<p>II Microbial genetics</p>	<p>Genetic analysis in Bacteria: Prototrophs, Auxotrophs. Genetic Mapping in Bacteria by Conjugation: Discovery of Conjugation in E.coli. The sex factor F, High-Frequency Recombination Strains of E.coli. F' Factors. Using conjugation to map bacterial genes- Interrupted-mating Genetic mapping in bacteria by Transformation.</p> <p>Genetic mapping in Bacteria by Transduction: Bacteriophages - Lytic and Lysogenic pathway. Transduction Mapping of Bacterial Chromosomes - Generalized Transduction and Specialized Transduction.</p>	<p>15</p>
<p>III Population genetics</p>	<p>Genetic Structure of Populations – Genetic structure of populations-Genotypic Frequencies and Allelic Frequencies, Hardy- Weinberg Law and its Assumptions Genetic Variations in Populations, Forces responsible for change in gene frequencies in population- Natural Selection. Genetic Drift migration Speciation Role of Population Genetics in Conservation Biology</p>	<p>15</p>
<p>Textbooks:</p> <ol style="list-style-type: none"> 1. iGenetics – A molecular approach Peter J Russell 3rd edition. 2. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology (2005) – P.S. Verma and Agarwal- S. Chand dinon Publications <p>Additional References:</p>		

Course Code	Course Title	Credits	Lectures /Week
KUSBT22106	Paper VI Molecular biology-1	2	3
About the Course:			
Course Objectives:			
<ul style="list-style-type: none"> To acquaint students with DNA Replication, Repair and Genetic Engineering 			
Learning Outcomes:			
After successful completion of this course, students would be able to <ul style="list-style-type: none"> Impart the knowledge of molecular Biology Techniques 			
Unit	Topics	No of Lectures	
I DNA Composition, Chromosome, DNA structure and packing	The Composition and structure of DNA and RNA: Nucleotide and Nucleoside, Structure of nucleotides. Structure of DNA. DNA double helix – Watson and Crick’s Model. Structure of RNA. Types of RNA. Organization of DNA in chromosome: Viral and Prokaryotic Chromosomes. Eukaryotic Chromosomes. Histone and Non-histone proteins. Nucleosome Structure. Packaging of DNA into chromosomes. Euchromatin and Heterochromatin. Centromeres and Telomeres Chromosome Banding Techniques. Karyotype and Idiogram Parameters used in Karyotype preparation- Human Karyotype (Normal) - Male and Female.	15	
II DNA	Models of DNA Replication DNA Replication in Prokaryotes	15	

replication	Evidence of Semi-conservative DNA replication- Meselson and Stahl's experiment DNA Polymerases and its role, E.coli Chromosome Replication, semi discontinuous replication Bidirectional Replication of Circular DNA molecules. Rolling Circle Replication, DNA Replication in Eukaryotes Enzymes and proteins involved in DNA replication	
III Mutation and repair	Definition of Mutations- Classification of mutations Types of Point Mutations, Types of Spontaneous and induced mutations Mutagenesis and types of Mutagens. (Examples of Physical, Chemical and Biological Mutagens) DNA REPAIR Photoreversal, Base Excision Repair, Nucleotide Excision Repair, Mismatch Repair, SOS Repair	15
Textbooks: 1. genetics – A molecular approach Peter J Russell 3rd edition 2. Biochemistry - U Satyanarayana U.Chakrapani, (2013) 4th edition 3. Principles of Genetics. E J Gardner, M J Simmons & D Peter Snustad. 8th edition Additional References: 1. Cell and Molecular Biology 5th edition by Gerald Karp (John Wiley and sons publications) 2. Genetics, (2006) Strickberger MW - (Prentice Hall, India) (recombination repair) 3.		

Course Code	Course Title	Credits	Lectures /Week
KUSBT22107	Paper VII Ability Enhancement Course Communication skills	2	3
About the Course:			
Course Objectives:			
<ul style="list-style-type: none"> To acquaint the students with concepts of Societal Awareness 			
Learning Outcomes:			
After successful completion of this course, students would be able to			

- To impart knowledge of Society and make students aware about the Problems in Society

Unit	Topics	No of Lectures
<p style="text-align: center;">I Academic skills</p>	<p>Essentials of Grammar: Parts of speech, Articles, Modals, Sentences and their types., Punctuation marks Employment Communication: Introduction, Resume, Curriculum Vitae, Scannable Resume, Developing an Impressive Resume, Formats of Resume, Job Application or Cover Letter. Email Writing Professional Presentation: Nature of Oral Presentation, planning a Presentation, Preparing the Presentation, Delivering the Presentation Job Interviews: Introduction, Importance of Resume, Definition of Interview, Background Information, Types of Interviews, Preparatory Steps for Job Interviews, Interview Skill Tips, Changes in the Interview Process, FAQ During Interviews Group Discussion: Introduction, Ambience/Seating Arrangement for Group Discussion, Importance of Group Discussions, Difference between Group Discussion, Panel Discussion and Debate, Traits, Types of Group Discussions, topic based and Case based Group Discussion, Individual Traits</p>	15
<p style="text-align: center;">II Soft skills</p>	<p>Introduction to Soft Skills and Hard Skills Personality Development: Knowing Yourself, Positive Thinking, Johari's Window, Communication Skills, Non-verbal Communication, Physical Fitness Emotional Intelligence: Meaning and Definition, Need for Emotional Intelligence, Intelligence Quotient versus Emotional Intelligence Quotient, Components of Emotional Intelligence, Competencies of Emotional Intelligence, Skills to Develop Emotional Intelligence Etiquette and Mannerism: Introduction, Professional Etiquette, Technology Etiquette Communication Today: Significance of Communication, GSC's 3M Model of Communication, Vitality of the Communication Process, Virtues of Listening, Fundamentals of Good Listening, Nature of Non-Verbal Communication, Need for Intercultural Communication, Communicating Digital World</p>	15

III Professional skills	<p>Creativity at Workplace: Introduction, Current Workplaces, Creativity, Motivation, Nurturing Hobbies at Work, The Six Thinking Hat Method</p> <p>Ethical Values: Ethics and Society, Theories of Ethics, Correlation between Values and behavior, Nurturing Ethics, Importance of Work Ethics, Problems in the Absence of Work Ethics</p> <p>Capacity Building: Need and Importance of Capacity Building Elements of Capacity Building Zones of Learning Ideas for Learning Strategies for Capacity Building</p> <p>Leadership and Team Building: Leader and Leadership, Leadership Traits, Culture and Leadership, Leadership Styles and Trends, Team Building, Types of Teams</p> <p>Decision Making and Negotiation: Introduction to Decision Making, Steps for Decision Making, Decision Making Techniques, Negotiation Fundamentals, Negotiation Styles, Major Negotiation Concepts</p> <p>Stress and Time Management: Stress, Sources of Stress, Ways to Cope with Stress</p>	15
<p>Textbooks:</p> <ol style="list-style-type: none"> 1. Communications Skill-Sanjay Kumar and Pushp Lata Oxford University. 2. Soft Skills: An Integrated Approach to Maximise Personality Gajendra Singh Chauhan, Sangeeta Sharma <p>Additional References:</p>		

Semester II

Course Code	Course Title	Credits	Lectures /Week
KUSBT22201	Paper I Fundamentals of Biotechnology-2	2	3
About the Course:			
<p>Course Objectives:</p> <ul style="list-style-type: none"> • The learner would be able to learn Food technology and Food quality enhancement. • The learners acquires the knowledge of Introduction to Medical Biotechnology • The learner will gain the knowledge Vaccines 			
<p>Learning Outcomes:</p> <p>After successful completion of this course, students would be able to</p>			

- The learner will be able to impart skills about Food and Medical Biotechnology

Unit	Topics	No of Lectures
<p style="text-align: center;">I Food Biotechnology</p>	<p>Introduction to food biotechnology, History of microorganisms in food science and key developments</p> <p>Applications of biotechnology in fermented food products - Introduction to Unit Operations and Processes, Food processing & packaging (canning & bottling), Production of cultures</p> <p>Fermented food products – Bread, Vinegar, Sauerkraut, Single Cell Protein (SCP), Probiotics</p> <p>Food spoilage, food deterioration and contamination</p> <p>Methods of food preservation</p> <p>Indicators of Food Microbial Quality & Safety, HACCP, FSSAI & FDA</p>	1
<p style="text-align: center;">II Medical biotechnology</p>	<p>Introduction to Medical Biotechnology</p> <p>Vaccines</p> <p>Types of vaccines</p> <p>General vaccine production</p> <p>Large scale production of vaccine</p> <p>Trends in Vaccines Research</p> <p>Issues related to vaccine research</p> <p>Synthetic peptides as vaccine</p> <p>Antibody Production</p> <p>Gene therapy</p> <p>Organ transplant cloning</p> <p>Stem cells -Sources and applications</p>	1
III		1

<p>Genetic engineering</p>	<p>rDNA technology – Definition and developments What is genetic engineering? What is gene cloning? Strategy for cloning – How to clone a gene? How to construct rDNA? Source DNA [insert] Isolation of DNA from bacterial cell Enzymes in rDNA – 1. restriction endonuclease; 2. DNA ligase; . Enzymes to modify ends of DNA molecules - exonuclease;endonuclease; S1 nuclease; alkaline phosphatase; polynucleotide kinase; DNA polymerase and klenow fragment; reverse transcriptase; terminal deoxynucleotidyl transferase Vectors – Role as agents of transfer Features of plasmid vectors Plasmid vectors - pBR322 pUC BAC Plant virus vectors and Animal virus vectors Shuttle vector; Expression vector Introducing insert into cloning vector Host cells – E. coli; Bacillus subtilis; Saccharomyces cerevisiae; Xenopus oocytes; Mammalian fertilized egg cell Introducing vector into host – Prokaryote Eukaryote Identification of recombinant clones</p>	
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Textbooks:

1. Food Microbiology, 5th edition, William C. Frazier, Dennis C. Westhoff, N.M. Vanitha, McGraw Hill Education, India
2. Fundamentals of Food Biotechnology, 2nd edition, Byong H. Lee, Wiley Blackwell
3. Prescott's Microbiology, 9th edition, Joanne M. Willey, Linda M. Sherwood, Christopher J. Woolverton, McGraw-Hill, USA

Additional References:

1. Industrial Microbiology, A. H. Patel
2. Biotechnology Fundamentals by Dr. Firdos Alam Khan

3. Medical Biotechnology Glick 1st edition

Course Code	Course Title	Credits	Lectures /Week
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KUSBT22202	Paper II Cell biology and Microbiology-2	2	3
About the Course:			
Course Objectives:			
<ul style="list-style-type: none"> To acquaint students with concept of Biodiversity and Cell Biology 			
Learning Outcomes:			
After successful completion of this course, students would be able to			
<ul style="list-style-type: none"> To impart skill in handling and culture of Microorganisms 			
Unit	Topics	No of Lectures	
I Ultrastructure of Prokaryotic and eukaryotic cells	<p>Ultrastructure of Prokaryotic Cell: Concept of Cell shape, size and arrangement</p> <p>Bacterial structures external to cell wall - Flagella, Pili, Fimbriae, Capsule, Slime Layer, Sheath</p> <p>Cell Wall(Gram Positive and Negative); Structures internal to cell wall - Cell Membrane, nucleoid, Cytoplasm and cytoplasmic inclusion bodies and vacuoles, Genetic Material spores and cysts</p> <p>Ultrastructure of Eukaryotic Cell: Cell wall; Plasma membrane, Cytoplasmic Matrix, Nucleus –Nuclear Structure, nuclear envelope, nucleoplasm, Nucleolus; cytoplasmic structures – cytoplasmic inclusions, cytoplasmic organelles - Endoplasmic Reticulum; Golgi Apparatus; Mitochondria; Chloroplasts; Ribosomes; Lysosome - Endocytosis, Phagocytosis, Autophagy; Peroxisomes.</p> <p>Microfilaments, Intermediate Filaments, and Microtubules</p> <p>External Cell Coverings: Cilia And Flagella</p> <p>Comparison of Prokaryotic And Eukaryotic Cells</p>	15	
II Microbiology	<p>Definition of Growth Mathematical and expression of growth Growth curve Measurement of growth Efficiency of growth yield Synchronous growth Effect of nutrient on growth rate Continuous Culture of microorganisms Chemostat and Turbidostat Enumeration of Microorganisms- Direct and Indirect</p>	15	

	Methods Preservation and Maintenance of cultures	
III Virology	Historical perspective Special cases- TMV and Influenza General Characteristics of Viruses Host Range Viral Structure- Nucleic Acid, Capsid and Envelope General Morphology- Helical, Polyhedral, Enveloped, Complex. Taxonomy of Viruses Viral Multiplication -Multiplication of Bacteriophages and Animal Viruses Isolation, Cultivation, and Identification of Viruses - Growing Bacteriophages and animal viruses in the Laboratory Viral Identification	15
Textbooks: <ol style="list-style-type: none"> 1. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology by Verma and Agarwal 2. Cell and Molecular Biology by Karp, 6th Ed 3. The Cell by Cooper and Hausman, 4th Ed Additional References: <ol style="list-style-type: none"> 1. Microbiology Stanier 5th ed 2. Pelczar Ried and Chan 		

Course Code	Course Title	Credits	Lectures /Week
KUSBT22203	Paper III Basic Chemistry-2	2	3
About the Course:			
Course Objectives:			
<ul style="list-style-type: none"> To acquaint students with concepts in Thermodynamics, Kinetics and Redox Reactions 			
Learning Outcomes:			
After successful completion of this course, students would be able to <ul style="list-style-type: none"> To impart skills in Kinetics and Chemical Reactions 			
Unit	Topics	No of Lectures	

<p style="text-align: center;">I Thermodynamics</p>	<p>Thermodynamics: System, Surrounding, Boundaries Sign Conventions, State Functions, Internal Energy and Enthalpy: Significance, examples, (Numericals expected.)</p> <p>Laws of Thermodynamics and its Limitations</p> <p>Mathematical expression. Qualitative discussion of Carnot Cycle for ideal Gas and Mechanical Efficiency.</p> <p>Laws of Thermodynamics as applied to Biochemical Systems.</p> <p>Concept of Entropy, Entropy for Isobaric, Isochoric and Isothermal Processes.</p>	<p>15</p>
<p style="text-align: center;">II Chemical Kinetics</p>	<p>Reaction Kinetics: Rate of Reaction, Rate Constant, Measurement of Reaction Rates Order & Molecularity of Reaction,</p> <p>Integrated Rate Equation of First and Second order reactions (with equal initial concentration of reactants). (Numericals expected)</p> <p>Determination of Order of Reaction</p> <p>a) Integration Method b) Graphical Method c) Ostwald's Isolation Method d) Half Time Method. (Numericals expected).</p>	<p>15</p>
<p style="text-align: center;">III Oxidation Reduction reactions</p>	<p>Principles of Oxidation & Reduction Reactions</p> <p>Oxidizing and Reducing Agents</p> <p>Oxidation Number, Rules to assign Oxidation Numbers with examples Ions like Oxalate, Permanganate and Dichromate.</p> <p>Balancing Redox Reactions by Ion Electron Method Oxidation, Reduction, Addition and Substitution & Elimination Reactions.</p>	<p>15</p>
<p>Textbooks:</p> <p>1. Satyanarayana U. and Chakrapani 2. Textbook of Physical Chemistry- F.Y.B.Sc. - Chapter 1.2 (Unit 1) 2015 Edn 1. Prof. Mathur MMS Chemical Calculations</p> <p>Additional References:</p> <p>1. 2.</p>		

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Course Code	Course Title	Credits	Lectures /Week
KUSBT22204	Paper IV Biochemistry: Concept of Biomolecules-2 and analytical techniques	2	3

About the Course:

Course Objectives:

- To acquaint students with Bioorganic Molecules, and concepts in Enzymology,

Learning Outcomes:

After successful completion of this course, students would be able to

- To impart the knowledge of Classification, Structure and Characterization of Biomolecules

Unit	Topics	No of Lectures
I Proteins and amino acids	<p>Amino acids: General introduction, Classification and structures, properties (physical & chemical) Amino Acids as drugs.</p> <p>Titration Curve of Amino Acids. Concept of Isoelectric pH, Zwitterion Reactions of Amino Acids: Sorenson's Titration, Ninhydrin Test</p> <p>Proteins: Introduction, definition and functional classification.</p> <p>Classification of Proteins: Simple- Fibrous and Globular</p> <p>Conjugated- Nucleoprotein, Lipoprotein, Glycoprotein, Phosphoprotein, Chromoprotein, Metalloprotein</p>	15

	<p>Derived- Primary and Secondary</p> <p>Peptide bond- Features Example of Dipeptide, tripeptide Nonapeptide EG: Oxytocin, Vasopressin Amino acid composition of Bovine Cytochrome C and Bovine Chymotrypsinogen</p> <p>Three dimensional Structure of proteins: Concept of Monomeric, dimeric and multimeric proteins Primary structure - Peptide linkage, Native Secondary structure - Alpha Pleat and Beta fold; Spatial arrangements of adjacent amino acid residues Tertiary structure - Three Dimensional arrangement Quaternary structure Di and Multimeric proteins EG: structure of human Insulin</p> <p>Properties of proteins: Solubility, Molecular weight, Shape, Iso electric pH, Salting out of proteins for purification</p> <p>Protein Denaturation and folding- Denaturing agents and properties of denatured proteins</p>	
<p style="text-align: center;">II Enzymes</p>	<p>Introduction to biocatalysis Properties of Enzymes Substrate, Optimum conditions, Cosubstrate, Coenzyme, Cofactors Classification and Nomenclature (one reaction per class)</p> <p>Mechanism of Enzyme Action, Active Sites, Enzyme Specificity, Factors affecting enzyme activity (Effect of pH, Temperature, Substrate Concentration, Enzyme concentration)</p> <p>Enzyme Kinetics: Derivation of Michaelis-Menten Equation, Lineweaver-Burk plot, Concept of km</p> <p>Types of Enzyme Inhibitions - Irreversible & Reversible (Competitive, Uncompetitive, Non-Competitive)</p> <p>Isoenzymes (LDH, Alkaline Phosphatase, Creatine Phosphokinase)</p> <p>Allosteric Modulators, Co-Factors, Zymogens, Enzyme units</p>	<p style="text-align: center;">15</p>

	Enzymes as Biomarkers and diagnostic tools.(SGPT, SGOT, LDH, CPK) Industrial Applications of Enzymes	
III Basics of Analytical techniques	<p>Methods of Separation: Precipitation, Filtration, Distillation and Solvent Extraction Analytical Techniques</p> <p>Chromatography: Definition, Principles, Chromatographic performance parameters, Types Paper Chromatography, Thin Layer Chromatography, Column Chromatography (Principle and Applications)</p> <p>Spectroscopy - Colorimetry: Properties of electromagnetic radiation, interaction with matter, lasers</p> <p>Colorimetric assays - Principle, Beer-Lambert's Law, Measurement of Extinction, Derivation of $E = kcl$, Limitations of Beer-Lambert's Law, Filter Selection Examples of colorimetric and UV absorption assays</p> <p>Electrophoresis: General principles, Factors affecting electrophoresis, Types of support media used, Types of electrophoresis (Agarose gel electrophoresis, PAGE)</p>	15
<p>Textbooks:</p> <ol style="list-style-type: none"> 1.Nelson D. L., and Cox M. M. (2008). Leininger Principles of Biochemistry. 4th Edition. W H Freeman and Company 2. Principles and Techniques of Biochemistry and Molecular Biology, 7th edition, Keith Wilson & John Walker, Cambridge University Press. 3. <p>Additional References:</p> <ol style="list-style-type: none"> 1. 2. 3. 		

Course Code	Course Title	Credits	Lectures /Week
KUSBT22205	Paper VPhysiology and immunology	2	3

About the Course:**Course Objectives:**

- To acquaint students with Physiological Processes in Plants and Animals and to acquaint students with the concept of immunology
-

Learning Outcomes:

After successful completion of this course, students would be able to

- To impart the knowledge of Physiology and Immunological Techniques

Unit	Topics	No of Lectures
I Plant Physiology	Photosynthesis Hill's Reaction and its Significance, Light Reactions, Cyclic and Non-Cyclic Photo induced Electron Flow, Energetics of Photosynthesis, Dark Phase of Photosynthesis, Calvin Cycle, C-3, C-4, CAM pathways , Rubisco oxygenase activity Plant hormones - Auxin ,Gibberellins, Cytokinins, Ethylene, Abscissic acid Introduction to Secondary Metabolites	15
II Animal Physiology	Introduction to physiology. Concept of homeostasis. Body fluids- Major types of Body fluid. Blood – Functions of blood, general properties of blood, Composition of blood. Thrombocytes or Platelets.	15

	<p>Coagulation of blood. Theories of Coagulation. Haemolysis.</p> <p>Respiratory system: Phases of Respiration, Principle of gases exchange, Mechanism of breathing.</p> <p>Digestion and absorption – Mode of nutrition, Digestion: Digestion of foodstuffs, Digestion in humans. Absorption.</p> <p>Excretion – Organs of excretion. Types of excretory products. Excretion device in vertebrates (Humans) Kidney – Structure of kidney, Structure of nephron. Function of kidney. Urine formation. Dialysis.</p>	
<p style="text-align: center;">III Immunology</p>	<p>Introduction to Immunology: Overview of Immune Systems, Innate Immunity, Mechanisms of innate immunity, Acquired Immunity, Local and Herd Immunity, Humoral and Cellular Immunity - Factors Influencing and Mechanisms of each. Antigens: Immunogenicity Versus Antigenicity, Factors That Influence Immunogenicity, Epitopes, Haptens, Superantigens Antibodies: Basic Structure of Antibodies, Antibody-Mediated Effector Functions, Antibody Classes and Biological Activities, Antigenic Determinants on Immunoglobulins.</p>	<p>15</p>
<p>Textbooks:</p> <ol style="list-style-type: none"> 1. Leininger Principles of Biochemistry, 5th Edition- Nelson D. L., and Cox M. M. (2008) W H Freeman and Company 2. A textbook of plant physiology and biochemistry by S K. Verma (S Chand publications) part1- physiology- (photosynthesis) 3. Plant Physiology: Theory and Applications, 2e- S. L. Kochhar and Sukhbir Kaur Gujral , Cambridge University <p>Additional References:</p> <ol style="list-style-type: none"> 1. 2. 3. 		

Course Code	Course Title	Credits	Lectures /Week
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KUSBT22206	Paper VI Basic Computers and Biostatistics	2	3
About the Course:			
Course Objectives:			
<ul style="list-style-type: none"> To acquaint students with concepts in computers, computer networking and Biostatistics. 			
Learning Outcomes:			
After successful completion of this course, students would be able to			
<ul style="list-style-type: none"> To impart the skills in Computer, Networking and Biostatistics. 			
Unit	Topics	No of Lectures	
I Introduction to computers	<p>Introduction to computers: Overview and functions of a computer system, Input and output devices, Storage devices.</p> <p>Modern computers: The workstation, The Minicomputer, Mainframe Computers, Parallel processing Computer & The Super Computer</p> <p>Introduction to operating systems: Operating System concept, Windows, Unix/Linux & servers</p> <p>Word Processing - Basic Operations, Creating and Editing documents, Formatting documents. Spreadsheet - Creating and editing workbook, Organizing and formatting worksheets; Data analysis and management; Using formulas and functions</p> <p>Presentation Graphics - Creating and Editing Presentations, Designing and Enhancing Presentation, Delivering Presentation, Advanced Presentation Graphics.</p>	15	
II Computer networking	<p>Introduction to networking: various terminologies Associated hardware devices, gadgets (Router, Switch) tools, services, and resources</p> <p>Network Topologies and Protocols, LAN, WAN and MAN</p> <p>World Wide Web (WWW)</p> <p>Network security: fire walls</p> <p>Computer viruses: An overview of Computer viruses: What is a virus? Virus signs, how do they get transmitted? What are the dangers? General Precautions</p> <p>The Internet and Internet Services-Introduction, History of Internet, Internetworking Protocol, The Internet</p>	15	

	<p>Architecture, Managing the Internet, Connecting to Internet, Internet Connections: Dial-up Access, Leased Line, Integrated Services Digital Network (ISDN), Digital Subscriber Line (DSL), Cable, Modem</p> <p>Internet Address</p> <p>Internet Services: World Wide Web (WWW), Web Browser, Uniform Resource Locator (URL)</p> <p>Internet Search Engines</p> <p>WWW Development Languages</p> <p>Electronic Mail: E-mail Address, E-mail Message Format, E-mail Services, How E-mail Works</p> <p>File Transfer Protocol (FTP), How FTP Works, Terminal Network (Telnet), News, Internet Relay Chat (IRC) Uses of Internet</p>	
<p style="text-align: center;">III Biostatistics</p>	<p>Definition & Importance of Statistics in Biology</p> <p>Variables, Types of variables (Quantitative & Qualitative)</p> <p>Data, Sources of data, Types of data (Quantitative & Qualitative), Representation of Data and Graphs (Bar Diagrams, Pie Charts and Frequency distribution, Histogram, Polygon and Curve)</p> <p>Population and Sample, Significance of using samples, Sample size, Random variation, Sampling techniques (Simple random sampling, Systematic sampling, Stratified sampling, Cluster sampling, Multiphase sampling) and Non-probability sampling</p> <p>Types of Statistics (Descriptive & Inferential) - only introduction</p> <p>Descriptive statistics: Measures of central tendency - Mean, Mode, Median (Ungrouped & Grouped data)</p> <p>Measures of dispersion - Range, Variance, Standard deviation (Ungrouped & Grouped data), Coefficient of variation</p> <p>Measures of location - Percentiles, Interquartile range (Box-Whisker plot)</p> <p>Normal/Gaussian distribution, Standard normal deviate, Sampling variation, Standard error of mean</p>	<p style="text-align: center;">15</p>
<p>Textbooks:</p> <ol style="list-style-type: none"> 1. Goel, A. (2010). Computer Fundamentals. India: Pearson Education 2. Computer Literacy BASICS: A Comprehensive Guide to IC3 3. <p>Additional References:</p>		

1.
2.

Course Code	Course Title	Credits	Lectures /Week
KUSBT22207	Paper VII Ability Enhancement Course- Sustainable development and Environmental biotechnology	2	3
About the Course:			
Course Objectives:			
<ul style="list-style-type: none"> To acquaint the students with concepts of Globalization, Ecology and Environment 			
Learning Outcomes:			
After successful completion of this course, students would be able to			
<ul style="list-style-type: none"> To impart knowledge of Globalization, make students aware about the Problems in Society 			
Unit			
Unit		Topics	
No of Lectures		No of Lectures	
I ECOLOGY AND INTERACTION	CONCEPT of Ecosystems, Definition and Components- Structure and function of ecosystem aspects of ecosystems Food Chain and Food Web, Ecological Pyramids (Energy,Biomass and Number) Aquatic and Terrestrial Ecosystems , Nutrient Cycle and Biogeochemical Cycles: Water, Carbon, Oxygen, Nitrogen and Sulphur. different Abiotic Factors of ecosystem and adaptations to different abiotic factors Interactions- Commensalism, Mutualism, Predation and Antibiosis, Parasitism, competition Biodiversity and its conservation: Introduction – definition: genetic, species, ecosystem diversity, biogeographic classification of India, value of biodiversity, biodiversity at global, national and local levels, India as a mega diversity nation, Hotspots of biodiversity,	15	

	threats to biodiversity, conservation of biodiversity	
II Pollution and climate change	<p>Environmental Pollution Definition, Cause, effects and control measures of :- Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards. Role of an individual in prevention of pollution. Pollution case studies. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies. Sustainable development-Concept, basic principles of sustainable development, post-brundtland world, roots of sustainability, Indicators, paradigm towards new discipline-sustainability science.</p>	15
III Renewable sources of energy	<p>Introduction- Renewable and Non-renewable resources. The need for a sustainable lifestyle. Energy resources: Types of energy Non renewable energy - Oil, coal and its environmental impacts. Renewable energy – Hydroelectric power, Solar energy, Biomass energy, Biogas, Wind power and Geothermal energy. Biogas technology- biogas plant & types, biodigester. Biogas- composition, production and factors affecting production and uses. Biofuels – ethanol production. Microbial hydrogen production Biodiesel, Petrocrops.</p>	15
<p>Textbooks:</p> <ol style="list-style-type: none"> 1. Environmental Biotechnology- Alan Scragg 2nd edition 2. Environmental Biotechnology – M.H.Fulekar 3. Textbook of Environmental studies. For Undergraduate courses of all Branches. UGC, New Delhi. <p>Additional References:</p> <ol style="list-style-type: none"> 1. 2. 3. 		

Semester I Practicals

K ey	
Red	Major
Blue	Minor

Green

Assignments/ Case study etc

Course Code	Course Title	Credits	Lectures/ Week
	Practical I Practicals of USBT101 and USBT102	2	3
Course Objectives:			
<ul style="list-style-type: none"> • • • 			
1	Assignment on any one branch of Biotechnology.		
2	Analyse a case-study and write a report on any one recent application of Biotechnology (Not older than past 5 years)		
3	Field visit/ Virtual visit (website) of National/ International research institutes for research in biotechnology and have a group discussion during the lab session.		
4	Study of Microscope – Compound Microscope (Including Handling and storage), Dark Field Microscope, Phase Contrast Microscope, Fluorescent Microscope, TEM, SEM. (Including ray diagrams)		
5	Observation of microorganisms using bright field microscope - Protozoa, Molds and Yeasts, Algae – from natural habitat/permanent slides.		
6	Monochrome staining using any suitable material. (Bacteria/Plant/Animal tissue)		
7	Differential staining – Gram staining, Acid fast staining, Romanowsky staining.		
8	Special staining – cell wall, capsule, spores, negative staining.		
9	Fungal staining – wet mount (Lactophenol cotton blue/Methylene Blue)		
10	Preparation of media - Nutrient broth and Agar, MacConkey Agar, Sabouraud's Agar		
11	Sterilization of Laboratory Glassware and Media using Autoclave and Hot air oven		
12	Isolation techniques: T-streak, polygon method		
13	Colony Characteristics of Microorganisms.		
14	Use of Bergey's manual to help identify any one isolate		
15	Isolation of Yeasts from the natural environment.		
16	Study of morphology and colony characteristics of yeasts		
17	Fermentation of Sugarcane juice using yeast.		

18	Qualitative Estimation of Alcohol by Ritter Test.
19	Screening of antibiotic producers from soil by Crowded plate method. (Demonstration)
20	Screening of antibiotic producers from soil by Wilkins Overlay method. (Demonstration)

Course Code	Course Title	Credits	Lectures/Week
	Practical 2 Practicals of USBT103 and USBT104	2	3
Course Objectives:			
<ul style="list-style-type: none"> • • • 			
1	Safety in Chemistry Laboratory: Dress code, Dos and Don't, First Aid		
2	Preparation of Normal, Molar, Molal, Percent solution		
3	Preparation of solution - PPM and PPB		
4	Demonstration of pH meter and digital Balance		
5	Preparation of Acetate buffer pH 4.6, Carbonate buffer pH 6.8, Tris buffer pH 8.3		
6	Structures of Aldo series and Keto series of Monosaccharides, disaccharides and Polysaccharides		
7	Qualitative tests for carbohydrates; Molisch test, Benedict's test, Iodine test, Osazone formation		
8	Estimation of carbohydrates by Lane-Eynon method		
9	Qualitative tests for lipids		
10	Salowski's Test for Cholesterol		
11	Saponification of fats		
12	Determination of Acetic acid in Vinegar by Titrimetric Method.		
13	Determination of the amount of Fe(II) present in the given solution Titrimetrically		
14	Determination of amount of NaHCO₃ + Na₂CO₃ in the given solid mixture Titrimetrically		
15	Determination of the amount of Mg(II) present in the given solution complexometrically		
16	Determination of percent composition of BaSO₄ and NH₄Cl in the given mixture gravimetrically		
17	Practice problems on nomenclature of organic compounds (Identify organic compounds based on formulae or draw formulae from names).		

18	Construct a detailed flowchart for classification of organic compounds.
19	Characterization of Organic Compounds (any three organic compounds)
20	Assignment-Practice problems on stereochemistry (Identifying stereoisomers, conformations of specific compounds, chirality and symmetry elements; drawing stereoisomers; locating and naming stereogenic centers).

Course Code	Course Title	Credits	Lectures/Week
	Practica 3 USBTP103 and USBT106	2	3
Course Objectives:			
<ul style="list-style-type: none"> • • • 			
1	Study of mitosis from suitable plant material		
2	Study of meiosis from suitable plant material/Permanent slides/Photographs		
3	Study of mitosis using pre-treated root tips of <i>Allium cepa</i> to study the effect of mutagens-chemical (colchicine/ PDB) on mitosis		
4	Study the effect of UV radiation as a mutagenic agent		
5	Extraction of DNA from plant material		
6	Qualitative analysis of DNA		
7	Identification of types of point mutations from given DNA sequences		
8	Isolation of antibiotic/dye resistant mutants using replica plate technique.		
9	Demonstration of Ames test for mutagenicity.		
10	Study of Karyotype - Normal male and Normal female		
11	Barr body identification in cells of Buccal smear		

12	Problems based on Mendelian Genetics, its modifications and gene interactions.
13	Construction of pedigree charts and analysis of human genetic traits using Pedigree analysis.
14	Preparation of competent cells and demonstration of Bacterial transformation and mapping
15	Demonstration of Bacterial Conjugation and interrupted mating-based mapping
16	Demonstration of transduction and mapping
17	Study of Watson and Crick model of DNA using micrographs/Schematic representations.
18	Study of Semiconservative replication of DNA through micrographs/ Schematic representation.
19	Conduct a survey on observable genetic traits and compare those inventories with other students in groups. (Blood group, tongue rolling, earlobe attachment, PT C tasting etc.)
20	Study of blood groups ABO in humans

Semester II Practicals

Course Code	Course Title	Credits	Lectures/ Week
	Practical 1 USBT P201 Practicals of USBT201 and USBT202	2	3
Course Objectives: <ul style="list-style-type: none"> • • 			
1	Assignment-Write a report on a case study on any one food product developed at CFTRI.		
2	Write a SOP on any one Food safety procedure in compliance with Good Manufacturing Practices/Flow sheet of Unit operations for any two food products.		
3	Microbial examination of food and detection of Pathogenic Bacteria from Food Samples		
4	Microscopic determination of Microbial flora from Yoghurt and Lactic Acid Determination		

5	Isolation and characterization of organisms causing Food Spoilage (Using Bergey's Manual)
6	Isolation and characterization of food fermenting organism from idlibatter (Using Bergey's Manual)
7	Sauerkraut production and to analyze quality parameters during production (odour, color, pH, total acidity)
8	Determination of food preservative concentration (salt & sugar) using MIC.
9	Processing fruits for preparation and packaging of jams or jellies.
10	Detection of Food adulterants in food samples
11	Isolation of chromosomal DNA from <i>E. coli</i> and Agarose gel electrophoresis of the chromosomal DNA
12	Study of the structure of important a. animal viruses (rhabdo, influenza, paramyxo, hepatitis and retroviruses) using electron micrographs/diagrams. b. plant viruses (caulimo, gemini, tobacco ringspot, cucumber mosaic and alpha-alpha mosaic viruses) using electron micrographs/diagrams. (ϕ X174, T4, λ) using electron micrographs/diagrams
13	Isolation and enumeration of bacteriophages (PFU) from water/sewage samples using double agar layer technique
14	Motility by hanging drop method/stab culture
15	Methods of preservation of culture
16	Study of Growth Curve of <i>E. coli</i>
17	Preparation of vaccine (Demonstration) and Sterility testing of Vaccine
18	Enumeration by Breed's count
19	Isolation and Enumeration of microorganisms - Serial dilution, Surface spread method,
20	Isolation and Enumeration of microorganisms - Serial dilution, Pour plate method.

Course Code	Course Title	Credits	Lectures/Week
	Practical 2 USBTP202 Practicals of USBT203 and USBT204	2	3

Course Objectives:

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1	To determine enthalpy of dissolution of salt like KNO_3
2	Determine the rate constant for hydrolysis of ester using HCl as a catalyst
3	Study the kinetics of reaction between Thiosulphate ion and HCl
4	Study reaction between potassium Persulphate and Potassium Iodide kinetically and hence to determine order of reaction
5	Study the reaction between NaHSO_3 and KMnO_4 and balancing the reaction in acidic, alkaline and neutral medium
6	Study transfer of electrons (Titration of sodium thiosulphate with potassium dichromate)
7	Determination of the volume strength of hydrogen peroxide solution by titration with standardised potassium permanganate solution
8	Determination of amount of Oxalate and oxalic acid in the given solution Titrimetrically
9	Tutorial: Structure of Amino acids
10	Titration curve of amino acid
11	Qualitative analysis of amino acids and proteins
12	Separation by Paper Chromatography a. Amino acids b. Sugars
13	Separation by Thin layer chromatography c. Plants Pigments d. Fatty acids
14	Qualitative Assay of enzyme urease, amylase, dehydrogenase, catalase and protease from Plant/Animal/Microbial source.
15	Enzyme Kinetics: Study of the effect of pH, Temperature on activity of Amylase
16	Study of Effect of Substrate Concentration on amylase enzyme activity and determination of V_{max} and K_m
17	Study of Effect of inhibitors on amylase enzyme activity

18	Determination of absorption maxima of CuSO ₄ / K ₂ Cr ₂ O ₇		
19	Verification of Beer and Lambert's Law		
20	Estimation of Protein by Biuret method		
Course Code	Course Title	Credits	Lectures/Week
	Practical 3 - Practicals of USBT205 and USBT206	2	3
Course Objectives:			
•			
•			
•			
1	Study of Hill's reaction		
2	To measure the rate of photosynthesis by Winkler's method		
3	Effect of PGR on seed germination		
4	Solvent extraction of plant pigments and study the absorption spectra of pigments		
5	Qualitative detection of plant secondary metabolites using standard tests - e.g. Tests for tannins, flavonoids, alkaloids, terpenoids, saponins, steroids.		
6	Separation of Carotenoids by thin layer chromatography		
7	Quantitative estimation of sugars by DNSA method		
8	Effect of different concentrations of sodium chloride on RBC and determination of the concentration isotonic to blood.		
9	Study of human blood count (RBC and WBC) using Haemocytometer		
10	Estimation of Haemoglobin in human blood.		
11	Analysis of Urine.		
12	Demonstration of Phagocytosis		
14	Study of bacterial flora of skin (as a physical barrier in innate immunity) by swab method/Hand imprint method.		
15	Word Processing: <ol style="list-style-type: none"> a. Creating, Saving & Operating a document, Editing, Inserting, Deleting, Formatting, Moving & Copying Text. b. Find & Replace, Spell Checker & Grammar Checker, c. Document Enhancement (Borders, Shading, Header, Footer), d. Printing document (Page layout, Margins), Working with Graphics (Word Art), Working with Tables & Charts, Inserting Files (Pictures, Databases, Spreadsheets)		
16	Spreadsheet Applications: <ol style="list-style-type: none"> a. Worksheet Basics: Entering information in a Worksheet, Saving & Opening a Worksheet, Editing, Copying & Moving data, Inserting, Deleting & Moving Columns & Rows, Clearing a. Using formulas in spreadsheet for simple calculations 		

	b. Creating graphs, pie chart etc
17	Creation of Computer Presentations with graphics: a. Creation of slides, changing layout and using the design tab. b. Using the insert tab function for pictures, audio, video, shapes, smart art, word art, text box. c. Assigning Transitions and animation to slides.
18	Searching/Surfing on the internet
19	Measures of central tendency: Mean, median and mode for grouped and ungrouped data (Manual and Excel)
20	Measures of dispersion: Standard deviation for grouped and ungrouped data: standard value for the mean and proportion (Manual and Excel)

Evaluation Scheme for First Year (UG) under AUTONOMY

I. Internal Evaluation for Theory Courses – 40 Marks

- i) Continuous Internal Assessment 1 – 20 Marks
- (ii) Class Internal Assessment 2 – 20 Marks

II. External Examination for Theory Courses – 60 Marks

Duration: 2 Hours

Theory question paper pattern:

All questions are compulsory.

Question	Based on	Options	Marks
Q.1	Unit I, II, III,	<i>Any 12 out of 15</i>	12
Q.2	Unit I	<i>Any 2 out of 4</i>	12
Q.3	Unit II	<i>Any 2 out of 4</i>	12
Q.4	Unit III	<i>Any 2 out of 4</i>	12
Q.5	Unit I, II, III,	<i>Any 3 out of 6</i>	12

- All questions shall be compulsory with internal choice within the questions.
- Each Question may be sub-divided into sub questions as a, b, c, d, etc. & the allocation of Marks depends on the weightage of the topic.

III. Practical Examination

- Each core subject carries 50 Marks (30 marks External + 20 marks Internal)
- Duration: 2 Hours for each practical course.
- Certified Journal is compulsory for appearing at the time of Practical Exam

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</p> <p>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</p> <p>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, Immunoelectrophoresis, CIEP, Rocket Electrophoresis and 2-D Immunoelectrophoresis.</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)	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.

REFERENCES:

1. Biotechnology: Environmental Processes- Rehm and Reed- Wiley
2. Molecular Biotechnology- Glick and Pasternan ASM Press
3. Food Microbiology- Frazier
4. Industrial Microbiology- A. H. Patel
5. Industrial Microbiology- L. E. Casida- John Wiley & Sons
6. Introductory Biostatistics. 1st edition. (2003), Chap T. Le. John Wiley, USA
7. Methods in Biostatistics- B. K. Mahajan –Jaypee Brothers
8. Outlines of Biochemistry: 5th Edition, (2009), Eric Conn & Paul Stumpf ; John Wiley and Sons, USA
9. Principles of Biochemistry, 4th edition (1997), Jeffery Zubey, McGraw-Hill College, USA
10. Lehninger , Principles of Biochemistry. 5th Edition (2008), David Nelson & Michael Cox, W.H. Freeman and company, NY.
11. Fundamentals of Biochemistry. 3rd Edition (2008), Donald Voet & Judith Voet , John Wiley and Sons, I. USA
12. Biochemistry: 7th Edition, (2012), Jeremy Berg, Lubert Stryer, W.H.Freeman and company, NY
13. An Introduction to Practical Biochemistry.3rd Edition, (2001), David Plummer, Tata McGraw Hill Edu.Pvt.Ltd. New Delhi, India
14. Biochemical Methods.1st , (1995), S.Sadashivam, A.Manickam, New Age International Publishers, India
15. Textbook of Biochemistry with Clinical Correlations, 7th Edition, Thomas M. Devlin, January 2010,
16. Proteins: biotechnology and biochemistry, 1st edition (2001), Gary Walsch, Wiley, USA
17. Biochemical Calculations, 2nd Ed., (1997) Segel Irvin H., Publisher: John Wiley and Sons, New York.
18. Enzymes: Biochemistry, Biotechnology & Clinical chemistry, (2001) Palmer Trevor, Publisher: Horwood Pub. Co., England.
19. Microbiology–6th Edition (2006), Pelczar M.J., Chan E.C.S., Krieg N.R., The McGraw Hill Companies Inc. NY
20. Prescott’s Microbiology, 8th edition (2010), Joanne M Willey, Joanne Willey, Linda Sherwood, Linda M Sherwood, Christopher J Woolverton, Chris Woolverton, McGrawHil Science Engineering, USA
21. Text book of Medical Microbiology, Anantnarayan
22. Microbiology- Frobisher
23. General Principles of Microbiology- Stanier
24. Fundamental Principles of Bacteriology - A. J. Salle McGraw Hill
25. Genetics, (2006) Strickberger MW - (Prentice Hall, India)
26. Human Genetics- A. M. Winchester – MacMillan Press
27. Kuby immunology, Judy Owen , Jenni Punt , Sharon Stranford., 7th edition (2012), Freeman and Co., NY
28. Textbook of basic and clinical immunology, 1st edition (2013), Sudha Gangal and Shubhangi Sontakke, University Press, India
29. Immunology, 7th edition (2006), David Male, Jonathan Brostoff, David Roth, Ivan Roitt, Mosby, USA.

30. Introduction to Immunology- C V Rao- Narosa Publishing House
31. Cell and Molecular Biology – De Robertis- Lippincott Williams& Wilkins
32. Cell and Molecular Biology- Concepts and Experiments—Karp – Wiley International
33. iGenetics- Peter Russell -Pearson Education
34. Microbial Genetics- Freifelder –Narosa Publishing House
35. Genes XI, 11th edition (2012), Benjamin Lewin, Publisher - Jones and Barlett Inc. USA
36. Bioinformatics- methods and S.C.Rastogi, N. Mendiratta, PHL learning Pvt. Ltd. applications Genomics, Proteomics P.Rastogi 3rd edition and Drug discovery,
37. Molecular diagnostics- Fundamentals , methods and clinical applications – Buckingham and Flaws F.A. Davis Company Philadelphia.
38. Molecular diagnostics for the clinical laboratorian by coleman and Tsongalis , Humana press
39. Environmental Biotechnology Allan Scragg Oxford University press
40. Environmental Biotechnology Indu shekar Thakur IK International (Basic concepts and applications)
41. Research methodology- C.R. Kothari
42. Entrepreneurship – Kurup
43. Handbook of Entrepreneurship development- Basotia and Sharma
44. Phytochemical methods- J.C. Harbone
45. Plant drug analysis- Wagner and Blandt
46. Organic Chemistry, R.T. Morrison, R.N. Boyd and S.K. Bhattacharjee, 7th Edition, Pearson Education (2011).
47. Organic Chemistry, T.W.G. Solomon and C.B. Fryhle, 9th Edition, John Wiley & Sons, (2008)
48. A guide to mechanism in Organic Chemistry, 6th Edition, Peter Sykes, Pearson Education
49. Fundamentals of Organic Chemistry , G. Marc Loudon, 4th Edition Oxford
50. Organic Chemistry, L.G. Wade Jr and M.S. Singh, 6th Edition,2008 7. Organic Chemistry, Paula Y. Bruice, Pearson Education, 2008
51. Organic Chemistry, J.G. Smith, 2nd Edition Special Indian Edition, Tata 21 McGraw Hill
52. Organic Chemistry, S.H. Pine, McGraw Hill Kogakusha Ltd
53. Methods in Molecular Biophysics, Igor N S, N Zaccai & J Zaccai, (2007) Cambridge 2.
54. Advanced Methods in Protein Microsequencing, Witmann
55. Essential Biophysics, Narayanan, New Age Publ
56. Handbook of Molecular Biophysics (Methods & Application), 2009, HG Bohr, Wiley
57. Principles & techniques of Biochemistry & Molecular Biology, Wilson & Walker.

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

UNIVERSITY OF MUMBAI



Revised Syllabus for T.Y.B.Sc.
Programme- B.Sc.
Course- Biotechnology (USBT)
(Third Year – Sem. V & VI)

(Credit Based Semester and Grading System with effect from
the academic year 2018-2019)

TYBSC Biotechnology Course Structure

Semester V

Course code USBT	Title	Theory /Practical	Marks	Credits	Nos of Lectures & Practical
501	Cell biology	Theory	100	2.5	60
502	Medical Microbiology & Instrumentation	Theory	100	2.5	60
503	Genomes and Molecular Biology	Theory	100	2.5	60
504	Marine Biotechnology	Theory	100	2.5	60
P501+502	Cell biology+ Medical Microbiology & Instrumentation	Practical	100	3.0	72
P503+504	Genomes and Molecular Biology+ Marine Biotechnology	Practical	100	3.0	72
Applied Component	Biosafety	Theory	100	2.0	48
	Biosafety	Practical	100	2.0	48
	TOTAL		800	20	480

Semester VI

Course code USBT	Title	Theory/ Practical	Marks	Credits	Nos of Lectures & Practical
601	Biochemistry	Theory	100	2.5	60
602	Industrial Microbiology	Theory	100	2.5	60
603	Pharmacology and Neurochemistry	Theory	100	2.5	60
604	Environmental Biotechnology	Theory	100	2.5	60
P 601-P 602	Biochemistry& Industrial Microbiology	Practical	100	3	72
P 603-P 604	Pharmacology - Neurochemistry and Environmental Biotechnology (50M)+ Project work (50M)	Practical	100	3	72
Applied component	Agribiotechnology	Theory	100	2.0	48
Applied component	Agribiotechnology	Practical	100	2.0	48
	TOTAL		800	20	480

Teaching pattern:

One (01) Credit would be of thirty- forty (30-40) learning hours; of this more than fifty percent of the time will be spent on class room instructions including practical as prescribed by the University. Rest of the time spent invested for assignments, projects, journal writing, case studies, library work, industrial visits, attending seminars / workshops, preparations for examinations etc. would be considered as notional hours. The present syllabus considers (60L as class room teaching and 15 lectures as Notional hours/ paper). Each lecture duration would be for 48 min

The names of the reference books provided in the syllabus are for guidance purpose only. Students and faculty are encouraged to explore additional reference books, online lectures, videos, science journals for latest/ additional information.

Examination pattern for:

Theory:

- The question paper for the Term End Exam would be of **100 marks** consisting of 5 Questions (20M each), of which one question would be common for all units in the syllabus.
- The question paper would be set for 150 marks including internal options.
- There shall be no internal exam for any paper.

Practical:

- Would be conducted over a period of 3 days; 50M each paper.
- Each student to perform 2 major and 2 minor practical for Sem V and 2 major and project presentation for Sem VI ,
- Viva would be conducted during the practical during Sem V; Sem VI would have ONLY project presentation
- Journals would be uniform throughout all the centres; matter would be communicated to all the centres by the syllabus committee.
- Distribution of marks for the experiments carried out during the examination:

Sem V (50M/ paper): Major: 20M; Minor: 10M; Viva: 10M; Journal 10M.

Sem VI (50M/paper): Major (x2): 40M; Journal: 10M; Project 50M

The report could be around 25-30 pages with appropriate referencing and formatting.

Marks distribution for the project would be as follows:

25M documentation, 15M presentation, 10 M viva and interactions;

- Students would undertake a project for 1-2 months during the last semester for 50 M. The project **should** include **either** of the following:
 1. One/ more major instrumentation OR
 2. One / more major technique/s required in the field of interest OR
 3. Bioinformatics OR
 4. Biostatistics

Semester V

Course code USBT	Title	Unit	Topics	Credit	No of Lectures
501	Cell Biology	I: Cell cycle	Cell cycle Introduction: Prokaryotic and Eukaryotic- 3 Lectures; The Early Embryonic Cell Cycle and the Role of MPF- 4 Lectures; Yeasts and the Molecular Genetics of Cell-Cycle Control – 4 Lectures; Apoptosis, Cell-Division Controls in Multicellular Animals- 4 Lectures	2.5	15
		II: Cell Signalling	Cell signalling and signal transduction:Introduction General Principles of Cell Signaling - 3 Lectures; Signaling via G-Protein-linked Cell-Surface Receptors - 3 Lectures; Signaling via Enzyme-linked Cell-Surface Receptors - 3 Lectures; Target-Cell Adaptation, The Logic of Intracellular - 3 Lectures; Signaling: Lessons from Computer-based "Neural Networks"- 3 Lectures		15
		III: Developmental Biology	Overview of how the modern era of developmental biology emerged through multidisciplinary approaches - 5 Lectures; Stages of development- zygote, blastula, gastrula, neurula cell fate & commitment – potency- concept of embryonic stem cells, differential gene expression, terminal differentiation ,lineages of three germ layers, fate map - 6 Lectures; Mechanisms of differentiation- cytoplasmic determinants, embryonic induction, concept of morphogen, mosaic and regulative development Pattern formation-- axis specification, positional identification (regional specification), Morphogenetic movements, Model organisms in Developmental biology - 4 Lectures		15
		IV: Cancer Biology	Cancer: Introduction, Cancer as a Microevolutionary Process - 4 Lectures; The Molecular Genetics of Cancer - 6 Lectures; Cancer and Virus Cancer diagnosis and chemotherapy - 5 Lectures		15
		Total			60

References:

1. Molecular Cell Biology. 7th Edition, (2012) Lodish H., Berk A, Kaiser C., K Reiger M., Bretscher A., Ploegh H., Angelika Amon A., Matthew P. Scott M.P., W.H. Freeman and Co., USA
2. Molecular Biology of the Cell, 5th Edition (2007) Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter. Garland Science, USA
3. Cell Biology, 6th edition, (2010) Gerald Karp. John Wiley & Sons., USA
4. The Cell: A Molecular Approach, 6th edition (2013), Geoffrey M. Cooper, Robert E. Hausman, Sinauer Associates, Inc. USA
5. Developmental Biology; Scott Gilbert; 9th Edition

Course code USBT	Title	Unit	Topics	Credit	No of Lectures
502	Medical Microbiology and Instrumentation	I: Virology	Introduction to viruses-Position in biological spectrum; Virus properties - 2 Lectures ; General structure of viruses Baltimore Classification and Taxonomy(ICTV) - 2 Lectures ; Cultivation of viruses - 2 Lectures ; Reproduction of ds DNA phages Hepatitis /ss RNA (influenza), animal viruses and plant (TMV)virus - 4 Lectures ; Virus purification and assays - 2 Lectures ; Cytocidal infections and cell damage - 2 Lectures ; Viroids and Prions - 1 Lecture	2.5	15
		II: Chemotherapeutic drugs	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 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		15

	III: Spectroscopy	Principle, instrumentation, working and applications of: Fluorescence Spectroscopy - 3 Lectures Luminometry - 3 Lectures Light scattering spectroscopy - 3 Lectures Infrared Spectroscopy - 3 Lectures Atomic absorption Spectroscopy - 3 Lectures	15
	IV: Bio-analytical techniques	Principle, working and applications of: Affinity chromatography - 2 Lectures Ion-exchange chromatography - 2 Lectures Molecular (size) exclusion chromatography - 2 Lectures ; HPLC - Method development and validation- 3 Lectures ; Isotopes in Biology: Nature of radioactivity - 1 Lecture ; Detection Techniques using GM counter, Scintillation counter, autoradiography - 4 Lectures ; Applications of Tracer techniques in Biology - 1 Lecture	15
	Total		60

References:

1. Principles and techniques in biochemistry and molecular biology (2010), Keith Wilson and John Walker, 7th edition, Cambridge University Press
2. Biophysics (2002) Vasantha Pattabhi and N. Gautham, Kluwer Academic Publishers
3. Physical Biochemistry: principles and applications, 2nd edition (2009), David Sheehan, John Wiley & Sons Ltd
4. HPLC method validation for pharmaceuticals: a review (2013), Harshad V. Paithankar, International Journal of Universal Pharmacy and Bio Sciences 2(4): July-August.
5. Mim's Medical Microbiology 5th edition
6. Microbiology by Prescott Harley and Klein 5th edition Mc Graw Hill
7. Medical Microbiology Jawetz, E., Brooks, G.E, Melnick, J.L., Butel, J.S Adelberg E. A 18th edition
8. Medical Microbiology by Patrick Murray 5th edition
9. Foundations In Microbiology by Talaro and Talaro Third edition W.C Brown
10. Understanding Viruses by Teri Shors

PRACTICALS

USBT P 501-502

3 credits

72hrs

1. Separation of components from a mixture using Affinity chromatography
(Kit may be used)
2. Separation of components from a mixture using ion exchange chromatography
(Kit may be used)
3. Separation of components from a mixture using Size exclusion chromatography
(Kit may be used)
4. HPLC method validation.
5. MIC and MLC of any one antibiotic
6. Antibiotic sensitivity test using agar cup method
7. Antibiotic sensitivity test using paper disc method
8. Antibiotic sensitivity test using ditch method.
9. Cancer Biology: (Field visit and 2 page report in the journal)
10. Chick embryo candling and inoculation methods Demonstration experiment
11. Book review (Emperor of all Maladies)

Course Code USBT	Title	Unit	Topics	Credit	No of Lectures
503	Genomics and Molecular Biology	I: Genetic engineering of plants	Genetic engineering of plants; Methodology. Plant transformation with the Ti plasmid of <i>A.tumefaciens</i> , Ti plasmid derived vector system - 4 Lectures ; Transgenic plants: Physical methods of transferring genes to plants : electroporation, microprojectile bombardment, liposome mediated, protoplast fusion- 5 Lectures ; Vectors for plant cells - 4 Lectures ; Improvement of seed quality protein - 2 Lectures	2.5	15
		II: Transgenic Animals	Transgenic mice- methodology-retroviral method, DNA microinjection, ES method - 5 Lectures ; genetic manipulation with cre-loxP - 2 Lectures ; Vectors for animal cells - 2 Lectures ; Transgenic animals recombination system - 2 Lectures ; Cloning live stock by nuclear transfer - 2 Lectures ; Green Fluorescent Protein - 1 Lectures ; Transgenic fish – 1 Lectures		15
		III: Tools in Molecular Biology	Cloning vectors-Plasmids (pUC series), Cosmids, phagemids M13, shuttle vectors, YAC vectors, expression vectors pET - 4 Lectures ; Gene cloning-Isolation and purification of DNA; Isolation of gene of interest: Restriction digestion, electrophoresis, blotting, cutting, and joining DNA, methods of gene transfer in prokaryotes and eukaryotes - 3 Lectures ; Recombinant selection and screening methods: genetic, immunochemical, Southern and Western analysis, nucleic acid hybridization, HART,HRT- 2 Lectures ; Expression of cloned DNA molecules and maximization of expression - 2 Lectures ; Cloning strategies-genomic DNA libraries, cDNA libraries, chromosome walking and jumping - 4 Lectures		15
		IV: Gene sequencing and editing	Maxam Gilbert's method, Sanger's dideoxy method, Automated DNA sequencing, Pyrosequencing - 6 Lectures ; Human genome mapping and it's implications in health and disease - 3 Lectures ; RNAi, ZNF(Zinc finger nucleases), TALENS(Transcription Activator Like Effector Nucleases), CRISPER/Cas system(Clustered Regularly Interspersed Repeats) - 6 Lectures		15
		Total			60

References:

1. iGenetics A Molecular Approach 3rd Edition Peter J. Russell.
2. Molecular Biotechnology-Principles and Applications of Recombinant DNA Technology 3rd Edition Glick B.R., Pasternak J.J., Patten C.L.
3. Principles of Gene Manipulation 7th Edition Primrose S.B., Twyman R.M.
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. Genomics Cantor C.R., and Smith C.L. John Wiley & Sons. (1999)

Course Code USBT	Title	Unit	Topics	Credit	No. of Lectures
504	Marine Biotechnology	I: Marine Biotechnology-Introduction & Bioprospecting	Introduction to Marine Biotechnology- 1 lecture; The marine ecosystem and its functioning: intertidal, estuarine, salt marsh, mangrove, coral reef, coastal & deep sea ecosystems. Hydrothermal vents- 4 lectures; Bioprospecting, Marine Microbial Habitats and Their Biotechnologically relevant Microorganisms- 2 lectures; Methods for Microbial Bioprospecting in Marine Environments - 2 lectures; Biotechnological Potential of Marine Microbes - 1 lecture; Bioactive compounds from other Marine Organisms: fungi, Microalgae, Seaweeds, Actinomycetes, sponges - 5 lectures	2.5	15
		II: Marine Drugs and Enzymes	Drugs from Marine organisms: Pharmaceutical compounds from marine flora and fauna - marine toxins, antiviral and antimicrobial agents - 4 lectures; Approved Marine Drugs as Pharmaceuticals - 2 lecture; Marine Natural products and its Challenges - 2 lectures; Marine Microbial Enzymes- Marine Extremozymes and Their Significance, Current Use of Marine Microbial Enzymes - 7 lectures.		15
		III: Marine Functional foods and Nutraceuticals	Marine Functional Foods: Marine Sources as Healthy Foods or Reservoirs of Functional Ingredients - 3 lectures; Marine-Derived Ingredients with Biological Properties- 3 lectures; Functional Foods Incorporating Marine-Derived Ingredients - 2 lectures; Marine Nutraceuticals : Marine Bioactives as Potential Nutraceuticals, Functional Carbohydrates, Polyunsaturated Fatty Acids- 3 lectures; Carotenoids, Soluble Calcium, Fish Collagen and Gelatin, Marine Probiotics - 4 lectures.		15
		IV: Marine Bioresources and	Marine Bioresources, Marine Secondary Metabolites, Marine Proteins, Marine Lipids- 4 lectures; Cosmetics from Marine Sources: Scenario of Marine Sources in the Cosmetic Industry, Cosmetics: Definition and Regulations,		15

		Cosmetics	Cosmeceuticals , Target Organs and Cosmetics Delivery Systems , Components of Cosmetics, Major Functions of Some Marine Components in Cosmetics and Cosmeceuticals , Treatments Based on Marine Resources , Products Based on Marine Resources - 11 lectures.		
		Total			60

References:

1. Kim, S.K. Springer Handbook of Marine Biotechnology; Springer: Berlin, Germany; Heidelberg, Germany, 2015.
2. Nollet, Leo M. L- Marine microorganisms- extraction and analysis of bioactive compounds-CRC Press_Taylor& Francis (2017)
3. R. S. K. Barnes, R. N. Hughes(auth.)-An Introduction to Marine Ecology, Third Edition-Wiley-Blackwell (1999)
4. Blanca Hernández-Ledesma, Miguel Herrero-Bioactive Compounds from Marine Foods-Plant and Animal Sources-Wiley-Blackwell (2013)
5. Fabio Rindi, Anna Soler-Vila, Michael D. Guiry (auth.), Maria Hayes (eds.)-Marine Bioactive Compounds_ Sources, Characterization and Applications-Springer US (2012)
6. W. Evans-Trease and Evans Pharmacognosy 15 th ed.-Saunders (2010)

PRACTICALS

USBT P 503-504

3 credits

72hrs

1. Transformation in *E.coli*.
2. Genomic DNA Extraction: Animal cells.
3. Restriction enzyme digestion and ligation (Kit may be used).
4. Phage titration: *Demonstration*
5. Polymerase chain reaction. *Demonstration*
6. Gradient plate technique
7. Bacterial gene expression (Kit may be used).
8. Study of any 5 marine bacteria and algae (Macro and micro)
9. DPPH assay for antioxidant extracted from marine algae
10. Extraction of carotenoids from marine algae/Bacteria/Fungi
11. Extraction and estimation of Gelatin / Collagen.
12. Extraction of alkaloids from marine organisms and their separation by TLC.

Course	Title	Unit	Topics	Credits	Lectures
Applied component	Biosafety	I: Introduction to biosafety	Introduction - 1 lecture Biological Risk Assessment, Hazardous Characteristics of an Agent- 2 lectures ; Genetically modified agent hazards - 1 lecture ; Cell cultures - 1 lecture ; Hazardous Characteristics of Laboratory Procedures - 1 lecture ; Potential Hazards Associated with Work Practices – 2 lectures ; Safety Equipment and Facility Safeguards - 2 lectures ; Pathogenic risk and management - 2 lectures	2.0	15
		II: GLP	Concept of GLP- 1 lectures ; Practicing GLP- 1 lecture ; Guidelines to GLP - 2 lectures ; Documentation of Laboratory work - 1 lectures ; Preparation of SOPs - 2 lectures ; Calibration records - 1 lectures ; Validation of methods - 1 lectures ; Documentation of results - 1 lecture ; Audits & Audit reports - 1 lecture.		12
		III: Detection and testing of contaminants	Microbial Contamination in food and pharma product - 3 lectures ; Some common microbial contaminants - 3 lectures ; Microbiological Assays for pharmaceutical products - 4 lectures ; Regulatory Microbiological testing in pharmaceuticals - 3 lectures.		12
		IV: Biosafety in Biotechnology	Concepts on biosafety in Biotechnology - 2 lectures ; Regulating rDNA technology - 2 lectures ; Regulating food and food ingredients - 3 lectures ; Genetically engineered crops, livestock Bioethics - 3 lectures ; Contemporary issues in Bioethics - 2 lectures.		12
		Total			48

References:

1. Pharmaceutical Microbiology - Hugo, W.B, Russell, A.D 6th edition Oxford Black Scientific Publishers.
2. Biosafety in Microbiological and Biomedical Laboratories - 5th Edition, L. Casey Chosewood Deborah E. Wilson U.S. Department of Health and Human Services Centers for Disease Control and Prevention National Institutes of Health.
3. Molecular Biotechnology –Principles and Applications of Recombinant DNA Glick, B.R, Pasternak, J.J Patten, C.L 3rd edition ASM press

PRACTICALS**Applied Component- Biosafety****2 Credits****48hours**

1. Validation of micropipette, measuring cylinders, colorimeters
2. Calibration of pH meter and weighing balance
3. Vitamin B12 bioassay
4. Testing for adulterants in food; ex. Starch in milk
5. Making SOP for any 2 major laboratory instruments
6. Sterility of injectables

Semester VI

Course Code USBT	Title	Unit	Topics	Credits	Lectures
601	Biochemistry	I: Protein Biochemistry	Protein structure: Protein Tertiary and Quaternary Structures - 2 Lectures ; Protein Denaturation and Folding – 3 Lectures ; Protein Function: Reversible Binding of a Protein to a Ligand: Oxygen-Binding Proteins – 2 Lectures ; Complementary Interactions between Proteins and Ligands: Immunoglobulins – 1 Lecture ; Protein Interactions Modulated by Chemical Energy: Actin, Myosin, and Molecular Motors - 3 Lectures ; Protein purification – 4 Lectures .	2.5	15
		II: Metabolism	Carbohydrate biosynthesis and its regulation: Peptidoglycan in Bacteria - 2 Lectures ; Starch and sucrose in Plants - 4 Lectures ; Glycogen in Animals - 4 Lectures ; Biosynthesis and regulation of Cholesterol, Atherosclerosis – 5 Lectures .		15
		III: Endocrinology	Mechanism of action of group I and II hormones- 1 Lecture ; Structure, storage, release, transport, biochemical functions and disorders associated with hormones secreted by Hypothalamus - 1 Lecture ; Anterior Pituitary gland - GH, stimulating hormones) - 1 Lecture ; Posterior Pituitary gland – oxytocin and vasopressin - 1 Lecture ; Thyroid gland – Thyroxine, calcitonin - 2 Lectures ; Parathyroid gland – PTH - 1 Lecture ; Adrenal medulla – epinephrine and norepinephrine - 1 Lecture ; Adrenal cortex – Glucocorticoids - 1 Lecture ; Pancreas – insulin and glucagon - 2 Lectures ; Female Gonads – estrogen and progesterone - 2 Lectures ; Male gonads – testosterone- 1 Lecture ; Placenta – hCG - 1 Lecture .		15
		IV:	Minerals and Vitamins;		

		Nutrition	Dietary sources, bioactive form, functions and disorders associated with fat soluble (A D E K) and water soluble vitamins- 7 Lectures; Minerals - physiological and biochemical functions of principal and trace elements. - 7 Lectures; Malnutrition – Over nutrition (obesity) and PEM (Kwashiorkor and Marasmus)- 1 Lecture.		15
		Total			60

References:

1. Lehninger, principles of biochemistry, 4th edition (2005), David Nelson and Michael Cox *W.H. Freeman* and Company, New York.
2. Biochemistry , 4th edition (2010), Voet and Voet, John Wiley and sons, USA
3. Harper’s Illustrated Biochemistry, 27th edition, RK Murray, DK Granner, PA Mayes and VW Rodwell, McGraw Hills publication.
4. Biochemistry, 4nd edition (2017), Satyanarayana and Chakrapani, Books & Allied (P) Ltd
5. Nutrition Science, 6th edition (2017), Srilakshmi, new age international publishers.

Course Code USBT	Title	Unit	Topics	Credit	No. of Lectures
602	Industrial Microbiology	I: Dairy technology	Milk: Normal flora, changes in raw milk - 2 lectures ; Enumeration - 1 lecture ; Factors affecting bacteriological quality - 1 lecture ; Dairy technology Preservation methods - 2 lectures ; Pasteurization- 1 lecture ; Starter Cultures - 2 lectures ; Fermented products-Production process and spoilage of Cheese: Swiss and Cheddar - 2 lectures ; Butter - 2 lectures ; Yogurt - 1 lectures and Buttermilk - 1 lecture .	2.5	15
		II: Down-stream Processing (DSP)	Introduction of DSP - 2 lectures ; Foam separation - 1 lecture ; Types of Precipitation - 1 lecture ; Filtration 2 lectures , Centrifugation - 1 lecture ; 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 .		15
		III: Fermentation process	Introduction to Inoculum development - 2 lectures ; Bacterial and fungal inoculum development with one example each - 3 lectures , scale up, scale down - 2 lectures ; Production of: Streptomycin - 1 lecture ; Protease - 1 lecture ; Mushroom - 1 lecture ; Glutamic acid - 1 lecture ; Lysine - 1 lecture , ethanol production 1 lecture Semi-synthetic Penicillin 1 lecture , Biotransformation - 1 lecture .		15
		IV: QA-QC	Concept of GMP- 1 Lectures ; Requirements of GMP implementation - 2 Lectures ; Documentation of GMP practices - 2 Lectures ; Regulatory certification of GMP - 2 Lectures ; Quality Control (QC): Concept of QC - 2 Lectures ; Requirements for implementing QC -		15

			2 Lectures; QA concepts: Concept of QA - 2 Lectures; Requirements for implementing - 2 Lectures.		
		Total			60

References:

1. Applied Dairy Microbiology Elmer H Marth and James L Steele Mercel Dekker Inc
New York, 2nd edition
2. Microbial Technology Peppler,H.J and Perlman,D 2nd Academic Press Practicals
3. Industrial Microbiology Prescott and Dunn CBS publishers
4. Dairy technology by Yadav and Grower
5. Fermentation technology by Stanbury and Whittkar
6. Pharmaceutical Microbiology by Russel and Hugo

PRACTICALS

USBT P 601-602

3 credits

72hrs

1. Estimation of Milk protein-Pynes method
2. Microbial analysis of Milk by MBRT and RRT
3. Phosphatase test in Milk
4. DMC of milk sample
5. Isolation of Normal flora from Milk and curd
6. Determination of blood glucose levels for detection of diabetes mellitus.
7. Determination of serum cholesterol (total, HDL and LDL ratio)
8. Estimation vitamin C by DCPIP method from food samples.

Course Code USBT	Title	Unit	Topics	Credits	No of Lectures
603	Basic pharmacology and Neurochemistry	I: General principles of Pharmacology	Mechanism of drug action - 2 Lectures ; drug receptors and biological responses - 2 Lectures ; second-messenger systems, the chemistry of drug-receptor binding - 2 Lectures ; dose-response relationship: therapeutic index - 3 Lectures ; ED, LD, - 2 Lectures ; Potency and Intrinsic Activity - 2 Lectures ; Drug antagonism - 2 Lectures .	2.5	15
		II: Drug Absorption and Distribution	Absorption of drugs from the alimentary tract - 2 Lectures ; factors affecting rate of gastrointestinal absorption - 2 Lectures ; absorption of drugs from lungs - 1 Lecture ; skin - 1 Lecture ; absorption of drugs after parenteral administration factors influencing drug distribution - 2 Lectures ; binding of drugs to plasma proteins - 2 Lectures ; Physiological barriers to drug distribution - 3 Lectures .		15
		III: Basic Toxicology and Regulatory Toxicology	Background Definitions - 1 Lectures ; Causation: degrees of certainty Classification - 1 Lectures ; Causes Allergy in response to drugs Effects of prolonged administration: chronic organ toxicity - 2 Lectures ; Adverse effects on reproduction - 1 Lecture ; <u>Poisons</u> : Deliberate and accidental self-poisoning Principles of treatment Poison-specific measures General measures - 2 Lectures ; Specific poisonings: cyanide, methanol, ethylene glycol, hydrocarbons, volatile solvents, heavy metals, - 3 Lectures ; herbicides and pesticides, - 2 Lectures ; biological substances (overdose of medicinal drugs is dealt with under individual agents) - 1 Lecture ; Incapacitating agents: drugs used for torture - 1 Lecture ; Nonmedical use of drugs - 1 Lecture .		15
		IV: Neurochemistry	Anatomy and functioning of the brain - 2 Lectures ; Neuronal pathways - 2 Lectures ;		15

			Propogation of nerve impulses - 2 Lectures; Neuronal excitation and inhibition - 3 Lectures; Synapses and gap junctions - 3 Lectures; Action of Neuro toxins and neurotransmitters - 3 Lectures.		
		Total			60

References:

1. Textbook of Medical Physiology Guyton, A.C and Hall 11th edition J.E Saunders
2. Modern Pharmacology with clinical Applications Craig,C.R, Stitzel,R.E 5th edition
3. Clinical Pharmacology Bennet,PN,Brown,M.J, Sharma,P 11th edition Elsevier
4. Biochemistry Metzler, D.E Elsevier

Course Code USBT	Title	Unit	Topics	Credits	No of Lectures
604	Environmental Biotechnology	I: Renewable sources of energy	Energy sources renewable – solar energy, wind power, geothermal energy and hydropower, biomass energy - 5 Lectures ; Biogas technology- biogas plant & types, biodigester. Biogas- composition, production and factors affecting production, uses - 5 Lectures ; Biofuels – ethanol production. Microbial hydrogen production Biodiesel, Petrocrops - 5 Lectures ;	2.5	15
		II Industrial effluent treatment	Biological processes for industrial effluent treatment, aerobic biological treatment- activated sludge process, CASP, advanced activated sludge processes (any two) Biological filters, RBC, FBR - 5 Lectures ; Anaerobic biological treatment- contact digesters, packed bed reactors, anaerobic baffled digesters, UASB - 3 Lectures ; Solid waste treatment - 2 Lectures ; pollution indicators & biosensors - 2 Lectures ; biodegradation of xenobiotics- persistent compounds, chemical properties influencing biodegradability, microorganisms in biodegradation - 2 Lectures ; Use of immobilized enzymes or microbial cells for treatment - 1 Lecture .		15
		III Wastewater treatment	Wastewater treatment- introduction, biological treatment, impact of pollutants on biotreatment, use of packaged organisms and genetically engineered organisms in waste treatment - 5 Lectures ; Heavy metal pollution – sources, microbial systems for heavy metal accumulation, techniques used for heavy metal removal - 5 Lectures ; biosorption by bacteria, fungi and algae, factors affecting biosorption limitations of biosorption - 5 Lectures .		15
		IV Hazardous waste management	Biodegradation of waste from tanning industry - 2 Lectures ; petroleum industry - 2 Lectures ; paper & pulp industry - 2 Lectures ; Dairy - 2 Lectures ; Distillery - 2 Lectures ; Dye - 1 Lecture ; Antibiotic industry - 2 Lectures ; Removal of oil spillage & grease deposits - 2 Lectures .		15
		Total			60

References:

1. Environmental Biotechnology Allan Scragg Oxford University press
2. Environmental Biotechnology (Basic concepts and applications) Indu Shekar Thakur
IK International
3. Environmental Biotechnology (Industrial pollution management) S.D. Jogdand
Himalaya Publishing House

PRACTICALS

USBT P 603-604

3 credits

72hrs

1. LD 50, ED 50 evaluation using suitable models e.x daphnia
2. Study the effect of heavy metals on the growth of bacteria.
3. Determination of Total Solids from an effluent sample.
4. Study of physico-chemical (pH, color, turbidity, BOD, COD) parameters of any one industrial effluent sample
5. Estimation of chromium from Effluents (Demonstration)
6. Visit to ETP/ CETP

Course	Title	Unit	Topics	Credit	No. of Lectures
Applied component	Agri Biotechnology	I: Precision Agriculture and Agriculture systems	Introduction to Agriculture and Agriculture systems- 1 Lecture ; Green house Technology-- Types of green house, importance, functions and features of green house, Design criteria and calculation - 2 Lectures ; Construction material, covering material and its characteristics, growing media, green house irrigation system. nutrient management - 3 Lectures ; Greenhouse heating, cooling and shedding and ventilation system, Computer controlled environment - 3 Lectures ;; Phytotrons, fertigation and roof system - 1 Lecture ; Precision Cultivation- tools, sensors for information acquisition - 2 Lectures .	2	12
		II: Plant stress biology	Abiotic stress –Physiological and molecular responses of plants to water stress, salinity stress, temperature stress – heat and cold, Photooxidative stress, stress perception and stress signaling pathways, Ionic and osmotic homeostasis, reactive oxygen species scavenging- 4 Lectures ; Biotic stress - plant interaction with bacterial, viral and fungal pathogens, plant responses to pathogen–biochemical and molecular basis of host-plant resistance , toxins of fungi and bacteria , systemic and induced resistance –pathogen derived resistance, signalling - 8 Lectures .		12
		III: Molecular Markers in Plant Breeding	Genetic markers in plant breeding-- Classical markers, DNA markers (RFLP, RAPD, AFLP, SSR, SNP)- 4 Lectures ; Application of Molecular Markers to Plant Breeding [quantitative trait locus (QTL) mapping] - 4 Lectures ; Plant DNA Barcoding- Barcoding Markers (matK, rbcl, ITS, tmH-psbA), steps, recent advances, Benefits, Limitations - 4 Lectures .	12	

		IV: Biofertilizers and Biopesticides	Biofertilizer: Nitrogen-fixing Rhizobacteria - Symbiotic Nitrogen Fixers -2 Lectures; Nonsymbiotic Nitrogen Fixers Plant Growth Promoting Microorganisms-Phosphate-Solubilizing Microbes (PSM), Phytohormones and Cytokinins, Induced Systemic Resistance- 2 Lectures; Plant Growth Promotion by Fungi--Mycorrhizae Arbuscular Mycorrhizae Ectomycorrhizae -2 Lectures; Microbial Inoculants -- Inocula, Carriers, and Applications, Monoculture and Co-culture Inoculant Formulations Biocontrol, Polymicrobial Inoculant Formulations- 3 Lectures; Biopesticides – types, Bacillus thuringiensis, insect viruses and entomopathogenic fungi (characteristics, physiology, mechanism of action and application) -3 Lectures.		12
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References:

1. M. Ajmal Ali, G. Gyulai, F. Al-Hemaid -Plant DNA Barcoding and Phylogenetics, LAP Lambert Academic Publishing (2015)
2. P. Parvatha Reddy (auth.)-Sustainable Crop Protection under Protected Cultivation- Springer Singapore (2016)
3. S.B. Anderson (ed.), Plant Breeding from Laboratories to Fields, InTech,2013
4. Henry Leung, Subhas Chandra Mukhopadhyay (eds.) - Intelligent Environmental Sensing (2015, Springer International Publishing)
5. Travis R. Glare, Maria E. Moran-Diez - Microbial-Based Biopesticides_ Methods and Protocols (2016, Humana Press)
6. Altieri, Miguel A.Farrell, John G-Agroecology- The Science Of Sustainable Agriculture, Second Edition-CRC Press (2018)
7. Arie Altman, Paul Michael Hasegawa-Plant Biotechnology and Agriculture_ Prospects for the 21st Century-Academic Press (2011)

PRACTICALS

Applied component-Agri-Biotechnology

USBT P 603-604

2 credits

48 hrs

1. RAPD analysis demonstration experiment
2. Isolation of Rhizobium
3. Isolation of Azotobacter
4. Isolation of Phosphate solubilising bacteria
5. Study of effect of abiotic stress on plants.
6. Rapid screening tests for abiotic stress tolerance (drought, - PEG, Mannitol & salinity NaCl)
7. Estimation of antioxidants and antioxidant enzymes - Ascorbate, Catalase, and Peroxidase
8. Visit to green house facility and submission of field visit report.