FY Bsc . BT . 2016-2021

Academic Council/07/2016
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UNIVERSITY OF MUMBAI

Syllabus for F.Y.B.Sc.

(Restructured)

Programme : B.Sc.

Course: Biotechnology

with effect from the academic year

2016 – 2017

Preamble:

Twenty First Century is known as the 'Century of Biotechnology'. Biotechnology is one of the youngest branches of Life Science, whichhas expanded and established as an advanced interdisciplinary applied science in last few years. Biotechnology at the core envisages the comprehensive study of Life and the Interdisciplinary potential of Biotechnology has led to aunique status for Biotechnology in Research and Industry.

The socio-economic potential of Biotechnology is well established which has almost become synonymous withmodern development. Biotechnology has its applications in almost every field touching practically every human activity. The applied aspect of Biotechnology is now getting established with its applications in Industry, Agriculture, Health and Environment, Biotechnology is the lead science expanding exponentially.

Biotechnology demands a trained, skilled human resource to establish the Industry and Research sectors. The field is novel and still expanding which demands inputs in Infrastructure and Technology. The global and local focus is on developing new technological applications isfast growing. Biotechnology sector in Research and Industry is expanding which is set to augur the next major revolution in the world.

The demand for trained workforce in Biotechnology is ever growing in Fundamental Research and Industry Sector. Academic and Research Sectors also require interdisciplinary trained manpower to further the Biotechnology Revolution.

The need of the hour is to design appropriate syllabi which keeps pace with changing times and technology with emphasizes on applications while elucidating technology in depth. The present Syllabi is Restructured anticipating the future needs of Biotechnology Sector with more emphasis on imparting *hands-on* skills. The main thrust is laid on making syllabus compatible with developments in Education, Research and Industrial sectors. The Theory and Practical course in new restructured course will lead to impart *skill-set* essentials to further Biotechnology Sector.

The restructured syllabus combines basic principals of Physical, Chemical and Biological sciences in light of advancements in technology. The curriculum aims to impart basic knowledge with emphasis on its applications to make the students industry ready.

Semester – I

Course Code	Course Type	Course Title	Credits	Lectures/Week
USBT101	Core Subject	**Basic Chemistry-I**	2	3
USBT102	Core Subject	**Basic Chemistry-II**	2	3
USBT103	Core Subject	**Basic Life Sciences-I : Biodiversity and Cell Biology**	2	3
USBT104	Core Subject	**Basic Life Sciences-II : Microbial Techniques**	2	3
USBT105	Core Subject	**Basic Biotechnology-I : Introduction to Biotechnology**	2	3
USBT106	Core Subject	**Basic Biotechnology-II : Molecular Biology**	2	3
USBT107	Ability Enhancement Course 1 (FC I)	**Societal Awareness**	2	3
USBTP101, USBTP102, USBTP103	Core Subject Practicals	Practicals of USBT101, USBT102, USBT103, USBT104, USBT105 and USBT106	6	18

Semester – II

Course Code	Course Type	Course Title	Credits	Lectures/Week
USBT201	Core Subject	**Chemistry-I : Bioorganic Chemistry**	2	3
USBT202	Core Subject	**Chemistry-II : Physical Chemistry**	2	3
USBT203	Core Subject	**Life Sciences-I : Physiology and Ecology**	2	3
USBT204	Core Subject	**Life Sciences-II : Genetics**	2	3
USBT205	Core Subject	**Biotechnology-I : Tissue Culture & Scientific Writing and Communication Skills**	2	3
USBT206	Core Subject	**Biotechnology-II : Enzymology, Immunology and Biostatistics**	2	3
USBT207	Ability Enhancement Course 2 (FC II)	**Globalization, Ecology and Sustainable Development**	2	3
USBTP201, USBTP202, USBTP203	Core Subject Practicals	Practicals of USBT201, USBT202, USBT203, USBT204, USBT205 and USBT206	6	18

SEMESTER – I

THEORY

SEMESTER I

Basic Chemistry-I

COURSE CODE	TITLE	CREDITS	Notional Hours
USBT 101	**Basic Chemistry I**	2	
Course Objective : To aquaint the students with basic concepts of Chemistylike Classification and Nomenclature of Chemical compounds **Learning Outcome** : To impart hands-on skills in preparation of Bufferes and Solutions			
Unit I **Nomenclature and Classification**	**Nomenclature and Classification of Inorganic Compounds:** Oxides, Salts, Acids, Bases, Ionic, Molecular and Coordination Compounds **Nomenclature andClassification of Organic Compounds:** Alkanes,Alkenes, Alkynes, Cyclic Hydrocarbons, Aromatic Compounds, Alcohols and Ethers, Aldehydes and Ketones, Carboxylic Acids and its derivatives, Amines, Amides, Alkyl Halides and Heterocylic Compounds	15 Lectures	30 hrs
Unit II **Chemical Bonds**	**Chemical Bonds:** **Ionic Bond:** Nature of Ionic Bond, Structur eof NaCl, KCl and CsCl, factors influencing the formation of Ionic Bond. **Covalent Bond:** Nature of Covalent Bond, Structure of CH4, NH3, H2O, Shapes of $BeCl_2$, BF3 **Coordinate Bond:** Nature of Coordinate Bond **Non Covalent Bonds:** Van Der Waal's forces: dipole - dipole, dipole – induced dipole. **Hydrogen Bond**: Theory of Hydrogen Bonding and Types of Hydrogen Bonding (with examples of RCOOH, ROH, Salicylaldehyde, Amides and Polyamides).	15 Lectures	30 hrs
Unit III **Water and Buffers**	**Chemistry of Water:** Properties of Water, Interaction of Water with Solutes (Polar, Non-Polar, Charged), Non-Polar Compounds in Water – Change in its Structure and the Hydrophobic Effect, Role of Water in Biomolecular Structure and Function and Water as a Medium for Life	15 lectures	30 hrs

	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. **Buffer solutions** –Concept of Buffers,Types of Buffers, Derivation of Henderson equation for Acidic and Basic buffers,Buffer action,Buffercapacity(Numericalsexpected.) pH of Buffer Solution.		

SEMESTER I

Basic Chemistry-II

COURSE CODE	TITLE	CREDITS	Notional Hours
USBT 102	**Basic Chemistry II**	**2**	
Course Objective : To aquaint students with Concepts of Steriochemisty **Learning Outcome** : To impart knowledge of Titrimetic and Volumetric Estimations and handling of basic Analytical Techniques like Chromatography and Colorimetry			
Unit I **Stereochemistry**	**Isomerism** – Types of Isomerism: Constitutional Isomerism (Chain, Position and Functional) and Stereoisomerism, Chirality. **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) **Conformation**: Conformations of Ethane. Difference between Configuration and Conformation. **Configuration**, Asymmetric Carbon Atom, Stereogenic/ Chiral Centers, Chirality,	15 Lectures	30 hrs

	Representation of Configuration by "Flying Wedge Formula" **Projection formulae** – Fischer, Newman and Sawhorse. The Interconversion of the Formulae.		
Unit II **Titrimetry and Gravimetry**	**Titrimetric Analysis**: Titration, Titrant, Titrand, End Point, Equivalence Point, Titration Error, Indicator, Primary and Secondary Standards, Characteristics and examples 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. Theory of Acid –Base Indicators, Choice and Suitability of Indicators. **Gravimetric Analysis:** Solubility and Precipitation, Factors affecting Solubility, Nucleation, Particle Size, Crystal Growth, Colloidal State, Ageing/Digestion of Precipitate. Co-Precipitation and Post-Precipitation. Washing, Drying and Ignition of Precipitate. (Numericals Expected).	15 Lectures	30 hrs
Unit III **Analytical Techniques**	**Methods of Seperation** Precipitation, Filtration, Distillation and Solvent Extraction. **Analytical Techniques** **Chromatography:** Definition, Principles, Types Introduction to Paper Chromatography, Thin Layer Chromatography, Column Chromatography and its Applications.**Colorimetry:** Principle, Beer-Lambert's Law, Measurement of Extinction, Derivation of E = kcl, Limitations of Beer-Lambart's Law, Filter Selection	15 Lectures	30 hrs

SEMESTER I

Basic Life Sciences-I : Biodiversity and Cell Biology

COURSE CODE	TITLE	CREDITS	Notional Hours
USBT 103	**Biodiversity and Cell Biology**	**2**	
Course Objectives : To aquint students with concept of Biodiversity and Cell Biology **Learning Outcome :** To impart skill in handling and culture of Microorganisms			
Unit I Origin of Life and Biodiversity (Animal,Plant, Microorganisms)	Origin of Life, Chemical and Biological Evolution, Origin of Eukaryotic Cell. Concept of Biodiversity, Taxonomical, Ecological and Genetic Diversity & its Significance **Introduction to Plant Diversity:** Algae, Fungi, Bryophyta, Pteridophyta, Gymnosperms and Angiosperms (with one example each) **Introduction to Animal Diversity:**Non-Chordates and Chordates {with at least one representative example.) **Introduction to Microbial Diversity** Archaebacteria, Eubacteria, Blue-green Algae, Actinomycetes, Eumycota-Habitats, Examples and Applications.	15Lectures	30 hrs
Unit II Ultra Structure of Prokaryotic and Eukaryotic Cell.	**Ultrastructure of Prokaryotic Cell:** Concept of Cell Shape and Size.Detail Structure of Slime Layer, Capsule, Flagella, Pilli, Cell Wall(Gram Positive and Negative), Cell Membrane, Cytoplasm and Genetic Material Storage Bodies and Spores **Ultrastructure of Eukaryotic Cell:** Plasma membranc, Cytoplasmic Matrix, Microfilaments, Intermediate Filaments, and Microtubules Organelles of the Biosynthetic-Endoplasmic Reticulum & Golgi Apparatus. Lysosome, Endocytosis, Phagocytosis, Autophagy, Proteasome Eucaryotic Ribosomes, Mitochondria and Chloroplasts	15Lectures	30 hrs

	Nucleus –Nuclear Structure, Nucleolus External Cell Coverings: Cilia And Flagella Comparison of Prokaryotic And Eukaryotic Cells		
Unit III **Bacteria and Viruses**	**Bacteria** : Classification, Types, Morphology (Size, Shape and Arrangement) Cultivation of Bacteria. Reproduction and Growth (Binary Fission, Conjugation and Endospore formation) Growth Kinetics, Isolation and Preservation. Significance of Bacteria **Viruses** :General Characters, Classification (Plant, Animal and Bacterial Viruses) Structure and Characterization of Viruses and Significance	15Lectures	30 hrs

SEMESTER - I

Basic Life Sciences-II : Microbial Techniques

COURSE CODE	TITLE	CREDITS	Notional Hours
USBT 104	**Microbial Techniques**	**2**	
Course Objectives : To aquaint students with basic techniques in Staining and Sterilization **Learning Outcome :**To impart the knowledge of growth of microorganisms			
Unit I **Microscopy and Stains**	**Microscopy and Stains** Microscope- Simple and Compound: Principle. Parts, Functions and Applications. Dark Field and Phase Contrast Microscope Stains and Staining Solutions- Definition of Dye and Chromogen. Structure of Dye and Chromophore. Functions of Mordant and Fixative. Natural and Synthetic Dyes. Simple Staining, Differential Staining and Acid Fast Staining with specific examples	15 lectures	30 hrs
Unit II **Sterilization Techniques**	Definition : Sterilization and Disinfection. Types and Applications Dry Heat, Steam under pressure,	15 lectures	30 hrs

	Gases, Radiation and Filteration Chemical Agents and their Mode of Action - Aldehydes, Halogens, Quaternary Ammonium Compounds, Phenol and Phenolic Compounds, Heavy Metals, Alcohol, Dyes, and Detergents Ideal Disinfectant. Examples of Disinfectants and Evaluation of Disinfectant		
Unit III **Nutrition, Cultivation and Enumeration of Microorganisms**	**Nutrition and Cultivation of Microorganisms** Nutritional Requirements : Carbon, Oxygen, Hydrogen, Nitrogen, Phosphorus, Sulphur and Growth Factors. Classification of Different Nutritional Trypes of Organisms. Design and Types of Culture Media. Simple Medium, Differential, Selective and Enrichem Media Concept of Isolation and Methods of Isolation. Pure Culture Techniques **Growth and Enumeration** Growth Phases, Growth Curve. Arithmatic Growth and Growth Yield. Measurement of Growth. Chemostat and Turbidostat Enumeration of Microorganisms- Direct and Indirect Methods Preservation of Cultures- Principle and Methods. Cryogenic Preservation Advantages and Limitations	15 lectures	30 hrs

SEMESTER I

Basic Biotechnology-I : Introduction to Biotechnology

COURSE CODE	TITLE	CREDITS	Notional Hours
USBT 105	**Introduction to Biotechnology**	**2**	
Corse Objectives : To auaint students with various fields of Biotechnology and their applications **Learining Outcome :** To impart the knowledge of Food Technology and Fermetation Techniques			
Unit I **Scope and Introduction to Biotechnology**	History & Introduction toBiotechnology What is Biotechnology? Definition of Biotechnology, Traditional and Modern Biotechnology, Branches of Biotechnology-	15 lectures	30 hrs

	Plant, Animal Biotechnology, Marine Biotechnology, Agriculture, Healthcare, Industrial Biotechnology, Pharmaceuti cal Biotechnology, Environmental Biotechnology. Biotechnology Research in India. Biotechnology Institutions in India (Pub lic and Private Sector) Biotech Sucess Stories Biotech Policy Initiatives Biotechnology in context of Developing World Public Perception of Biotechnology		
Unit II **Applications Biotechnology**	Applications of Biotechnology in Agriculture : GM Food, GM Papaya, GM Tomato, Fungal and Insect Resistant Plants BT Crops, BT Cotton and BT Brinjal Pros and Cons Biotechnological applications in Crop and Livestock Improvements Modifications in Plant Quality Golden Rice, Molecular Pharming, Plant Based Vaccines Ethics in Biotechnology and IPR	15 lectures	30 hrs
Unit III **Food and Fermentation Biotechnology**	**Food Biotechnology** Biotechnological applicationsin enhancement of Food Quality Unit Operation in Food Processing Quality Factors in Preprocessed Food Food Deterioration and its Control Rheology of Food Products Microbial role in food products Yeast, Bacterial and other Microorganisms based process and products Modern Biotechnological Regulatory Aspects in Food Industries Biotechnology and Food - Social Appraisal **Fermentation Technology** Defination, Applications of Fermetation Technology Microbial Fermentations Overview of Industrial Production of Chemicals (Acetic Acid, Citric Acid and Ethanol), Antibiotics, Enzymes and Beverages	15 lectures	30 hrs

SEMESTER - I

Basic Biotechnology-II : Molecular Biology

COURSE CODE	TITLE	CREDITS	Notional Hours
USBT 106	**Molecular Biology**	**2**	
Corse Objectives : To aquint students with DNA Replication, Repair and Genetic Engineering **Learning Outcome :**Impart the knowledge of molecular Biology Techniques			
Unit I **Replication**	DNA Replication in Prokaryotes and Eukaryotes- Semi-conservative DNA replication, DNA Polymerases and its role, E.coli Chromosome Replication, BidirectionalReplication of Circular DNA molecules. Rolling Circle Replication, DNA Replication in Eukaryotes DNA Recombination – Holliday Model for Recombination Transformation	15 lectures	30 hrs
Unit II **Mutation and DNA Repair**	Definition and Types of Mutations. Mutagenesis and Mutagens.(Examples of Physical, Chemical and Biological Mutagens) Types of Point Mutations, DNA REPAIR Photoreversal, Base Excision Repair, Nucleotide Excision Repair, Mismatch Repair, SOS Repair and Recombination Repair.	15 lectures	30 hrs
Unit III **Genetic Engineering**	Experimental evidences forDNA and RNA as Genetic Material. Genetic Engineering in Ecoli and other Prokaryotes, Yeast, Fungi and Mammalian Cells Cloning Vectors-Plasmids (pBR 322, pUC) Vectors for Plant and Animal Cells, Shuttle Vectors, YAC Vectors, Expression Vectors Enzymes- DNA Polymerases, Restriction Endonucleases, Ligases, Reverse Transcriptases, Nucleases, Terminal Transferases, Phosphatases Isolation and Purification of DNA (Genomic, Plasmid) and RNA,, Identification of Recombinant Clones	15 lectures	30 hrs

Semester – I

Practicals

SEMESTER – I
Practicals
Basic Chemistry

COURSE CODE	TITLE	CREDITS	Notional Hours
USBTP 101	Basic Chemistry	2	30 hrs

1. Safety Measures and Practices in Chemistry Laboratory, Working and use of a Digital Balance, Functioning and Standardization of *pH* Meter, Optical Activity of a Chemical Compounds by Polarimeter
2. Preparation of Standard (Molar, Molal and Normal solutions) and Buffer Solutions Determination of strength of HCl in commercial sample
3. Qualitative Analysis of Inorganic Compounds - Three experiments
4. Characterization of Organic Compounds containing only C, H, O elements (no element test) - Compounds belonging to the following classes: Carboxylic Acid, Phenol, Aldehyde/Ketone, Ester, Alcohol, Hydrocarbon and Characterization of Organic Compounds containing C, H, O, N, S, Halogen Elements (element tests to be done) Compounds belonging to the following classes: Amine, Amide, Nitro Compounds, Thiamide, Haloalkane, Haloarene
5. To Standardize commercial sample of NaOH using KHP (Potassium hydrogen pthalate) and sample of HCl using borax.
6. Dissociation Constant of Weak Acids by Incomplete Titration Method using *pH* Meterand determination of Acetic acid in Vinegar by Titrimetric Method
7. Determination of the amount of Fe (II) present in the given solution Titrimetrically
8. Determination of amount of NaHCO3 + Na2CO3 in the given solid mixture Titrimetrcially
9. Determination of the amount of Mg (II) present in the given solution complexometrically
10. Determination of percent composition of BaSO4 and NH4Cl in the given mixture Gravimetrically
11. Separation of Cu, Ni and Fe using Paper Chromatographyand amino acids - paper chromatography
12. Determination of fluoride ion using Colorimetry and Fe (III) by using Salicylic Acid by Colorimetric Titration

SEMESTER – I
Practicals
Basic Life Sciences

COURSE CODE	TITLE	CREDITS	Notional Hours
USBTP 102	Basic Life Science	2	30 hrs

1. Components and workingof Simple, Compound, Dark Field, Fluorescent and Phase Contrast Microscope
2. Staining of Plant and Animal Tissues using Single and Double Staining Techniques
3. Special Staining Technique for Cell Wall, Capsule and Endospores and Fungal Staining
4. Monochrome Staining, Differential Staining, Gram Staining, and Acid Fast Staining and Romonowsky Staining
5. Study of Plant, Animal and Microbial Groups with at least one examples from each x 3
6. Study of Photomicrographs of Cell Organelles
7. Sterilization of Laboratory Glassware and Media using Autoclave
8. Preparation of Media- Nutrient broth and Agar, MacConkey Agar, Sabourauds Agar
9. Isolation of Organisms : T-streak, Polygon method
10. Enumeration of microorganisms by Serial Dilution, Pour Plate, Spread Plate Method
11. Colony Characteristics of Microorganisms, Enumeration by Breed's count
12. Growth Curve of E.Coli

SEMESTER – I
Practicals
Basic Biotechnology

COURSE CODE	TITLE	CREDITS	Notional Hours
USBTP 103	Basic Biotechnology	2	30 hrs

1. Assignment- Study of any branch of biotechnology and its applications
2. Microbial examination of food and detection of Pathogenic Bacteria from Food Samples
3. Isolation of organisms causing Food Spoilage
4. Microscopic determination of Microbial flora from Yoghurt and Lactic Acid Determination
5. Analysis of Milk- Methylene Blue, Resazurin Test, Phosphatase Test
6. Extraction of Caesin from Milk
7. Meat Tenderization using Papain
8. Fermentative production of Alcohol
9. Determination of Alcohol content
10. Isolation and purification of DNA (genomic, plasmid)
11. Restriction Digestion
12. Agarose Gel Electrophoresis of the genomic and plasmid DNA

SEMESTER – II

THEORY

SEMESTER II

Chemistry-I : Bioorganic Chemistry

COURSE CODE	TITLE	CREDITS	Notional Hours
USBT 201	**Bioorganic Chemistry**	2	
Course Objectives : To aquint students with Bioorganic Molecules **Learning Outcome :** To impart the knowledge of Classification, Strucure and Characterization of Biomolecules			
Unit I **Biomolecules:** **Carbohydrates and Lipids**	**Carbohydrates:** Structure, Function, Classification, Characteristic Reactions, Physical and Chemical Properties, D & L Glyceraldehydes, structure of Monosaccharide, Disaccharides, and Polysaccharides. Isomers of Monosaccharides, Chemical/Physical Properties of Carbohydrate, Chemical Reactions for Detection of Mono., Di and Polysaccharides, **Lipids:**Classification of Lipids, Properties of Saturated, Unsaturated Fatty Acids, Rancidity, and Hydrogenation of Oils Phospholipids: Lecithin Cephalin, Plasmalogen Triacylglycerol-Structure and Functio n Sterols: Cholesterol: Structure and Fu nction , Lipoproteins: Structure and Fu nction, Storage Lipids, Structural Lipi ds, Action of Phospholipases, Steroids	15 lectures	30 hrs
Unit II **Biomolecules:** **Proteins and Amino Acids**	**Proteins and Amino Acids:** Classification, Preparation and Propert ies, Isoelectric Point, Peptide Synthesi s Proteins: Classification based on Struc ture and Functions, Primary Structure, N-terminal (Sanger and Edmans Meth od) and C-terminal Analysis (Enzyme) Reactions of Amino Acids, Sorenson' s Titration, Ninhydrin Test. Denaturation of protein Structure of Peptides. Titration Curve of Amino Acids. Concept of Isoelectric pH, Zwitter ion. Glycoproteins	15 lectures	30 hrs
Unit III	**Nucleic Acids:** Structure, Function of Nucleic Acids, Properties and Typesof	15 lectures	30 hrs

Biomolecules: Nucleic Acids	DNA, RNA. Structure of Purine and Pyrimidine Bases Hydrogen Bonding between Nitrogeneous Bases in DNA Differences between DNA and RNA, Structure of Nucleosides, Nucleotides and Polynucleotides.		

SEMESTER II

Chemistry-II : Physical Chemistry

COURSE CODE	TITLE	CREDITS	Notional Hours
USBT 202	**Physical Chemistry**	**2**	
Course Objectives : To aquaint students with concepts in Thermodynamics, Kinetics and Redox Reactions **Learning Outcome :** To impart skills in Kinetics and Chemical Reactions			
Unit I **Thermodynamics**	**Thermodynamics:** System, Surrounding, Boundaries Sign Conventions, State Functions, Internal Energy and Enthalpy: Significance, examples, (Numericals expected.) Laws of Thermodynamics and its Limitations, Mathematical expression. Qualitative discussion of Carnot Cycle for ideal Gas and Mechanical Efficiency. Laws of Thermodynamics as applied to Biochemical Systems. Concept of Entropy, Entropy for Isobaric, Isochoric and Isothermal Processes.	15 lectures	30 hrs
Unit II **Chemical Kinetics**	**Reaction Kinetics:** Rate of Reaction, Rate Constant, Measurement of Reaction Rates Order & Molecularity of Reaction, Integrated Rate Equation of First and Second order reactions (with equal initial concentration of reactants). (Numericals expected) Determination of Order of Reaction by a) Integration Method b) Graphical Method c) Ostwald's Isolation Method d) Half Time Method. (Numericals expected).	15 lectures	30 hrs
Unit III **Oxidation Reduction reactions**	**Principals of Oxidation & Reductio n Reactions–** Oxidising and Reducing Agents, Oxid ation Number, Rules to assign Oxidation Numbers wi th examples Ions like	15 lectures	30 hrs

	Oxalate, Permanganate and Dichromat e. Balancing Redox Reactions by Ion Electron Method Oxidation, Reduction, Addition and Substitution & Elimination Reactions.		

SEMESTER II

Life Sciences-I : Physiology and Ecology

COURSE CODE	TITLE	CREDITS	Notional Hours
USBT 203	**Physiology and Ecology**	**2**	
Course Objectives: To aquaint studetns with Physiological Processes in Plants and Animals **Learning Objectives :** To impart the knowledge of Physiology and Ecology			
Unit I **Plant Physiology**	Photosynthesis, Intracellular Organization of Photosynthetic System. Fundamental Reactions of Photosynthesis, Photosynthetic Pigments, Role of Light. Hill Reaction and its Significance, Light Reactions, Cyclic and Non-Cyclic Photo induced Electron Flow, Energetics of Photosynthesis, Photorespiration, Dark Phase of Photosynthesis, Calvin Cycle, C-3, C-4 pathways Plant hormones - Auxin ,Gibbrellins, Cytokinins, Ethylene, Abscissic acid Introduction to Secondary Metabolites	15 lectures	30 hrs
Unit II **Animal Physiology**	Physiology of Digestion Movement of Food and Absorption, Secretary functions of Alimentary Canal, Digestion and Absorption,assimilation in Gut of Mammals Anatomy of Mammalian Kidney, Structure of Nephron, Physiology of Urine Formation and Role of Kidney in Excretion and Osmoregulation Physiology of Respiration, Mechanism of Respiration Principles of Gaseous Exchange in the Blood and Body Fluids Blood and Circulation : Blood Composition, Structure and Function of its Constituents	15 lectures	30 hrs

	Blood Coagulation and Anti-Coagulants Hemoglobin and its Polymorphism Regulation of the Circulation Mechanism and working of Heart in Human.		
Unit III **Ecosystem and Interactions**	Ecology and Biogeography. Ecosystems, Definition and Compone nts, Structure and Function of Ecosystems. Aquatic and Terrestrial Ecosystems, Biotic and Abiotic Factors, Trophic Levels, Food Chain and Food Web, Ecological Pyramids (Energy,Biomass and Number) Nutrient Cycle and Biogeochemical Cycles: Water, Carbon, Oxygen, Nitrogen and Sulphur. Interactions, Commensalism, Mutualism, Predation and Antibiosis, Parasitism.	15 lectures	30 hrs

SEMESTER – II

Life Sciences-II : Genetics

COURSE CODE	TITLE	CREDITS	Notional Hours
USBT 204	**Genetics**	**2**	
Course Objectives : To aquaint students with concepts in Genetics **Learning Objectives :** To impart skills in Techniques in Genetic Analysis and Population Genetics			
Unit I **Genetics Fundamentals**	Mendel's Laws of Heredity Monohybrid Cross: Principle of Dominance and Segregation. Dihybrid Cross: Principle of Independent Assortment. Application of Mendel's Principles Punnett Square. Mendel's Principle in Human Genetics. Incomplete Dominance and Co-dominance. Multiple Alleles.Allelic series. Variations among the effect of the Mutation. Genotype andPhenotype. Environmental effect on the expression of the Human Genes. Gene Interaction. Epistasis.	15 lectures	30 hrs

Unit II **Microbial Genetics**	Genetic analysis in Bacteria- Prototrophs, Auxotrophs. Bacteriophages: Lytic and Lysogenic Development of Phage. Mechanism of Genetic Exchange in Bacteria: Conjugation; Transformation; Transduction; (Generalized Transduction, Specialized Transduction) Bacterial Transposable Elements.	15 lectures	30 hrs
Unit III **Population Genetics**	Genetic Structure of Populations – Genotypic Frequencies and Allelic Frequencies, Hardy- Weinberg Law and its assumptions Genetic Variations in Populations- Measuring Genetic Variation at Protein Level and measuring Genetic Variations at DNA level Natural Selection. Genetic Drift Speciation Role of Population Genetics in Consevation Biology	15 lectures	30 hrs

SEMESTER II

Biotechnology-I : Tissue Culture &Scientific Writing and Communication Skills

COURSE CODE	TITLE	CREDITS	Notional Hours
USBT 205	**Tissue Culture & Scientific Writing and Communication Skills**	**2**	
Course Objectives : To aquaint students with Techniques of Plant and Animal Tissue Culture **Learning Outcome :**To impart the skills of PTC, ATC and Science Communication			
Unit I **Plant Tissue Culture**	Cell Theory, Concept of Cell Culture, Cellular Totipotency, Organization of Plant Tissue Culture Laboratory : Equipments and Instruments Aseptic Techniques: Washing of Glassware, Media Sterilization, Aseptic Workstation, Precautions to maintain Aseptic Conditions. Culture Medium: Nutritional requirements of the explants, PGR's and their *in-vitro* roles, Media Preparation Callus Culture Technique: Introduction, Principle and Protocols	15 lectures	30 hrs

Unit II **Animal Tissue Culture**	**Basics of Animal Tissue Culture** Introduction Cell Culture Techniques, Equipment and Sterilization Methodology. Introduction to Animal Cell Cultures:Nutritional and Physiological: Growth Factors and Growth Parameters. General Metabolism and Growth Kinetics Primary Cell Cultures : Establishment and Maintenance of Primary Cell Cultures of Adherent and Non-Adherent Cell Lines with examples. Application of Cell Cultures	15 lectures	30 hrs
Unit III **Scientific Writing and Communication Skills**	**Communication Skills** Introduction to Communication -- Elements, Definitions, Scope of Communication and Communication as part of Science Communication Elements --Verbal and Non-Verbal Communications. Principles of Effective Communication, Oral Presentations Scientific Reading, Writing & Presentation **Scientific Writing** Process of Scientific Writing: Thinking, Planning, Rough Drafts and Revising Contents. Introduction to Scientific Reports and Writings Compilation of Experimental Data, Communication Methods in Science, Examples of Scientific and Unscientific Writing. Writing Papers, Reviews, Bibliography Plagiarism--Introduction to Plagiarism , Examples of Plagiarism.	15 lectures	30 hrs

SEMESTER - II

Biotechnology-II : Enzymology, Immunology and Biostatistics

COURSE CODE	TITLE	CREDITS	Notional Hours
USBT 206	**Enzymology, Immunology and Biostatics**	**2**	
Course Objectives : To aquaint students with concepts in Enzymology, Immunology and Biostatistics **Learning Outcome :** To impart the skills in Enzyme Kinetics, Immunological Techniques and Biostatistics			

Unit I **Enzymes**	Definition, Classification, Nomenclature, Chemical Nature, Properties of Enzymes, Mechanism of Enzyme Action, Active Sites, Enzyme Specificity, Effect of pH, Temperature, Substrate Concentration on Enzyme Activity, Enzyme Kinetics, Michelis-Menten Equation, Types of Enzyme Inhibitions-Competitive, Uncompetitive, Non-Competitive Allosteric Modulators Co-Factors,Zymogens,	15 lectures	30 hrs
Unit II **Immunology**	Overview of Immune Systems, Cell and Organs involved, T and B cells. Innate Immunity, Acquired Immunity, Local and Herd Immunity, Humoral and Cellular Immunity - Factors Influencing and Mechanisms of each. Antigens and Antibodies: Types of Antigens, General Properties of Antigens, Haptens and Superantigens Discovery and Structure of Antibodies (Framework region) Classes of Immunoglobulins, Antigenic Determinants. Antigen-Antibody Interactions Monoclonal Antibodies, Vaccines (Live, Killed) and Toxoid. Problems with Traditional Vaccines, Impact of Biotechnology on Vaccine Development.	15 lectures	30 hrs
Unit III **Biostatistics**	Defination &Importance of Statistics in Biology Types of Data, Normal and Frequency Distribution Representation of Data and Graphs (Bar Diagrams, Pie Charts and Histogram, Polygon and Curve) Types of Population Sampling Measures of Central Tendency (For Raw,Ungroup & Group Data) Mean Median Mode Measures of Dispersion Range, Variance, Coefficient of Variance. Standard Derivation. Standard Error.	15 lectures	30 hrs

Semester – II

PRACTICALS

SEMESTER – II
Practicals
Chemistry

COURSE CODE	TITLE	CREDITS	Notional Hours
USBTP 201	Chemistry	2	30 hrs

1. Spot test for Carbohydrates, Fats and Proteins and Amino Acids and Nucleic Acids
2. Standardization of Colorimeter and Estimation of Reducing sugar by DNSA method
3. Estimation of Protein by Biuret method and Lowry method
4. Saponification of Fats, Saponification Value of Oil or Fat, Iodine value of Oiland determine the rate constant for the saponification reaction between ethyl acetate and NaOH by back titration method
5. To determine enthalpy of dissolution of salt like KNO3
6. Determine the rate constant for hydrolysis of ester using HCl as a catalyst
7. Study the kinetics of reaction between Thiosulphate ion and HCl
8. Study reaction between potassium Persulphate and Potassium Iodide kinetically and hence to determine order of reaction
9. Study the reaction between NaHSO3 and KMnO4 and balancing the reaction in acidic, alkaline and neutral medium
10. Study transfer of electrons (Titration of sodium thiosulphate with potassium dichromate)
11. Determination of the volume strength of hydrogen peroxide solution by titration with standardised potassium permagnate solution
12. Determination of amount of K oxalate and oxalic acid in the given solution Titrimetrcially

SEMESTER – II
Practicals
Life Sciences

COURSE CODE	TITLE	CREDITS	Notional Hours
USBTP 202	Life Sciences	2	30 hrs

1. Study of Hill's reaction
2. Colorimetric study of Absorption Spectrum of Photosynthetic Pigments
3. Movemnt of Food in Paramoecium
4. Activity of Salivary Amylase on Starch
5. Analysis of Urine
6. Study of Mammalian Blood, Blood count using Haemocytometer and estimation of Haemoglobin in Mammalian Blood
7. Study of Human Blood Groups
8. Study of Mammalian Kidney and Heart
9. Problems in Mandelian Genetics
10. Study of Mitosis and Meiosis
11. Study of Karyotypes – Normal Male and Normal Female
12. Study of Interactions Commensalism, Mutualism, Predation and Antibiosis, Parasitism.

SEMESTER – II
Practicals
Biotechnology

COURSE CODE	TITLE	CREDITS	Notional Hours
USBTP 203	Biotechnology	2	30 hrs

1. Working and use of various Instruments used in Biotechnology Laboratory (Autoclave, Hot air Oven, Centrifuge, Incubator, Rotary Shaker, Filter Assembly, LAF, *pH* meter and Colorimeter)
2. Laboratory Organization and Layout for Plant and Animal Tissue Culture Laboratory
3. Preparation of Stock Solutions and Preparation of Media for PTC
4. Aseptic Transfer Technique, Surface Sterilization and Innoculation for Callus Culture
5. Media Preparation and Sterilization (ATC)
6. Trypsinization of Tissue and Viability Count
7. Qualitative Assay of Enzyme Amylase. Lipase, Protease, Urease, Catalase and Dehydrogenease
8. Enzyme Kinetics : Study of the effect of *pH*, Temperature on activity of Enzyme
9. Study of Effect of Substrate Concentration on enzyme activity and determination of Vmax and Km
10. Study of antigen antibody interaction by Ouchterlony method
11. Biometric Analysis for Mean, Median, Mode and Standard Deviation and Data representation using frequency Polygon, Histogram and Pie Diagram
12. Preparation of review reports of 5 Scientific Papers and Presentation (last 5 years)

Semester – I and II

Ability Enhancement Course 1 (FC I)
Ability Enhancement Course 2 (FC II)

SEMESTER I

Ability Enhancement Course 1 (FC I)

Societal Awareness

COURSE CODE	TITLE	CREDITS	Notional Hours
USBT 107	**Societal Awareness**	**2**	
Course Objective : To aquaint the students with concepts of Societal Awarness **Learning Outcome :** To impart knowledge of Society and make students aware about the Problems in Society			
Unit I **Overview of Indian Society**	Understand the multi-cultural diversity of Indian society through its demographic composition: population distribution according to religion, caste, and gender; Appreciate the concept of linguistic diversity in relation to the Indian situation; Understand regional variations according to rural, urban and tribal characteristics; Understanding the concept of diversity as difference	15 Lectures	30 hrs
Unit II **Concept of Disparity**	**Concept of Disparity- I** Understand the concept of disparity as arising out of stratification and inequality; Explore the disparities arising out of gender with special reference to violence against women, female foeticide (declining sex ratio), and portrayal of women in media;Appreciate the inequalities faced by people with disabilities and understand the issues of people with physical and mental disabilities **Concept of Disparity-II** Examine inequalities manifested due to the caste system and inter-group conflicts arising thereof; Understand inter-group conflicts arising out of communalism; Examine the causes and effects of conflicts arising out of regionalism and linguistic differences	15 Lectures	30 hrs
Unit III **The Indian Constitution and Significant Aspects of Political Processes**	**The Indian Constitution** Philosophy of the Constitution as set out in the Preamble; The structure of the Constitution-the Preamble, Main Body and Schedules; Fundamental Duties of the Indian Citizen; tolerance, peace and communal harmony as crucial values in strengthening the social fabric of Indian society; Basic features of the Constitution **Significant Aspects of Political Processes** The party system in Indian politics; Local self-government in urban and rural areas; the 73rd and 74th Amendments and their implications for inclusive politics; Role and significance of women in politics	15 lectures	30 hrs

Topics for Project Guidance: Growing Social Problems in India:

- *Substance abuse- impact on youth & challenges for the future*
- *HIV/AIDS- awareness, prevention, treatment and services*
- *Problems of the elderly- causes, implications and response*
- *Issue of child labour- magnitude, causes, effects and response*
- *Child abuse- effects and ways to prevent*
- *Trafficking of women- causes, effects and response*

SEMESTER II

Ability Enhancement Course 2 (FC II)

Globalization, Ecology and Sustainable Development

COURSE CODE	TITLE	CREDITS	Notional Hours
USBT 207	Globalization, Ecology and Sustainable Development	2	
Course Objective : To aquaint the students with concepts of Globalization, Ecology and Environment **Learning Outcome :** To impart knowledge of Globalization make students aware about the Problems in Society			
Unit I **Globalisation and Indian Society and Human Rights**	**Globalisation and Indian Society** Understanding the concepts of liberalization, privatization and globalization;Growth of information technology and communication and its impact manifested in everyday life; Impact of globalization on industry: changes in employment and increasing migration; Changes in agrarian sector due to globalization; rise in corporate farming and increase in farmers' suicides. **Human Rights** Concept of Human Rights; origin and evolution of the concept; The Universal Declaration of Human Rights;Human Rights constituents with special reference to Fundamental Rights stated in the Constitution	15 Lectures	30 hrs
Unit II **Ecology and Sustainbale Development**	**Ecologyand Sustainbale Development** Importance of Environment Studies in the current developmental context; Understanding concepts of Environment, Ecology and their interconnectedness; Environment as natural capital and connection to quality of human life; Environmental Degradation causes and impact on human life; Sustainable development, concept and components; poverty and environment	15 Lectures	30 hrs
Unit III **Understanding and Managing Stress and Conflict in Contemporary Society**	**Understanding Stress and Conflict** Causes of stress and conflict in individuals and society; Agents of socialization and the role played by them in developing the individual; Significance of values, ethics and prejudices in developing the individual; Stereotyping and prejudice as significant factors in causing conflicts in society. Aggression and violence as the public expression of conflict **Managing Stress and Conflict in Society** Types of conflicts and use of coping mechanisms for managing individual stress; Maslow's theory of self-actualisation;Different methods of responding to conflicts in society; Conflict-resolution and efforts towards building peace and harmony in society	15 lectures	30 hrs

Topics for Project Guidance: Growing Social Problems in India:

- *Increasing urbanization, problems of housing, health and sanitation;*
- *Changing lifestyles and impact on culture.*
- *Farmers' suicides and agrarian distress.*
- *Debate regarding Genetically Modified Crops.*
- *Development projects and Human Rights violations.*
- *Increasing crime/suicides among youth.*

Evaluation Scheme

The performance of the learners shall be evaluated into TWO Parts.
The learner's performance shall be assessed by Internal Assessment with 25 marks & by conducting the Semester End Examinations with 75 marks .
Practical Training will have Practical Examination for 50 marks at the end of Semester.
The allocation of marks for the Internal Assessment and Semester End Examinations are as follows:-

I. **Internal Exam-25 Marks**

(i) *Test– 20 Marks*

(ii) *Activities - 5 Marks*

II. **External Examination- 75 Marks**

(i) Theory Question Paper Pattern:-

All questions areCompulsory.		
Question	Based on	Marks
Q.1	Unit I	20
Q.2	Unit II	20
Q.3	Unit III	20
Q.4	Unit I,II and III	15

- 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 &e, etc & the allocation of Marks depends on the weightage of the topic.

III. **Practical Examination – 300 marks (50 marks x 6 core papers)**

Each Core Subject Carries 50 Marks

Chemistry : 30 marks + 10 marks (Journal)+ 10 marks(Viva-voce)

Life Sciences and Biotechnology : Major (20 marks), Minor (10 marks), Identification /Spots (10 marks), Viva-voce (5 marks), Journal (5 marks)

IV. **Ability Enhancement Course**

V. **Internal Exam-25 Marks**

(iii)*Project– 20 Marks*

(iv)*Activities - 5 Marks*

VI. **External Examination- 75 Marks**

Question Paper Pattern

Maximum Marks: 75, Questions to be set:04, Duration: 02 and 1/2 Hrs.
All Questions are Compulsory

Q-1 Objective Questions - 20Marks

A) Sub Questions to be asked 12 and to be answered any 10

B) Sub Questions to be asked 12 and to be answered any 10

(*Multiple choice / True or False / Match the columns/Fill in the blanks)

Q-2 Full Length Question – 20 Marks

OR

Full Length Question

Q-3 Full Length Question – 20 Marks

OR

Full Length Question

Q-4 Short Notes – 15 Marks (To be asked 06 To be answered 03)

Note: Theory question of 15 marks may be divided into two sub questions of 7/8 and 10/5Marks.

University of Mumbai

No. AAMS(UG)/ 172 of 2021-22

CIRCULAR:-

Attention of the Principals of the Affiliated Colleges and Directors of the Recognized Institutions in Faculty of Science & Technology is invited to this office circular No. UG/116 of 2016-17 dated 25th October, 2016 relating to the revised syllabus as per the (CBCS) for the F.Y.B. Sc. Biotechnology (Sem. I & II).

They are hereby informed that the recommendations made by the Ad-hoc Board of Studies in Biotechnology at its online meeting held on 16th July, 2021 and subsequently passed by the Board of Deans at its online meeting held on 23rd September, 2021 vide item No. 6.4 (R) have been accepted by the Academic Council at its meeting held on 10th November, 2021 **vide** item No. 6.3(R) and that in accordance therewith, the revised syllabus as per the (CBCS) for the F.Y.B.Sc. Bio-technology (USBT) (Sem.- I & II) accordingly has been brought into force with effect from the academic year 2022-23. (The same is available on the University's website www.mu.ac.in).

(Sudhir S. Puranik)
REGISTRAR

MUMBAI – 400 032
1st Feb, 2022

To

The Principals of the Affiliated Colleges and Directors of the Recognized Institutions in Faculty of Science & Technology.

A.C/6.3(R) /10/11/2021

****

No. AAMS(UG) 172-A of 2022

1st Feb, 2022

Copy forwarded with Compliments for information to:-

1) The Dean, Faculty of Science & Technology,
2) The Chairman, Ad-hoc Board of Studies in Biotechnology,
3) The Director, Board of Examinations and Evaluation,
4) The Director, Board of Students Development,
5) The Director, Department of Information & Communication Technology,
6) The Co-ordinator, MKCL.

(Sudhir S. Puranik)
REGISTRAR

Copy to :-

1. The Deputy Registrar, Academic Authorities Meetings and Services (AAMS),
2. The Deputy Registrar, College Affiliations & Development Department (CAD),
3. The Deputy Registrar, (Admissions, Enrolment, Eligibility and Migration Department (AEM),
4. The Deputy Registrar, Research Administration & Promotion Cell (RAPC),
5. The Deputy Registrar, Executive Authorities Section (EA),
6. The Deputy Registrar, PRO, Fort, (Publication Section),
7. The Deputy Registrar, (Special Cell),
8. The Deputy Registrar, Fort/ Vidyanagari Administration Department (FAD) (VAD), Record Section,
9. The Director, Institute of Distance and Open Learning (IDOL Admin), Vidyanagari,

They are requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to in the above circular and that on separate Action Taken Report will be sent in this connection.

1. P.A to Hon'ble Vice-Chancellor,
2. P.A Pro-Vice-Chancellor,
3. P.A to Registrar,
4. All Deans of all Faculties,
5. P.A to Finance & Account Officers, (F.& A.O),
6. P.A to Director, Board of Examinations and Evaluation,
7. P.A to Director, Innovation, Incubation and Linkages,
8. P.A to Director, Board of Lifelong Learning and Extension (BLLE),
9. The Director, Dept. of Information and Communication Technology (DICT) (CCF & UCC), Vidyanagari,
10. The Director of Board of Student Development,
11. The Director, Department of Students Walfare (DSD),
12. All Deputy Registrar, Examination House,
13. The Deputy Registrars, Finance & Accounts Section,
14. The Assistant Registrar, Administrative sub-Campus Thane,
15. The Assistant Registrar, School of Engg. & Applied Sciences, Kalyan,
16. The Assistant Registrar, Ratnagiri sub-centre, Ratnagiri,
17. The Assistant Registrar, Constituent Colleges Unit,
18. BUCTU,
19. The Receptionist,
20. The Telephone Operator,
21. The Secretary MUASA

for information.

AC 10/11/2021
Item No. 6.3

UNIVERSITY OF MUMBAI

Revised Syllabus for Program-

F.Y.B.Sc. Biotechnology (USBT)

(Sem. I & II)

(Choice Based Credit System)

With effect from the academic year 2022-2023

AC_____
Item No. _____

UNIVERSITY OF MUMBAI

Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course	F.Y.B.Sc.Biotechnology (USBT)
2	Eligibility for Admission	HSC (Science) with Physics, Chemistry, Mathematics and Biology. If the student has not opted for Mathematics in HSC, then he/she will have to complete 15 hours Bridge course in Mathematics
3	Passing Marks	40 %
4	Ordinances / Regulations (if any)	--
5	No. of Years / Semesters	03 Years/Six semesters
6	Level	~~Certificate~~/~~Diploma~~/UG/~~PG~~ **(Strike out which is not applicable)**
7	Pattern	Semester/~~Yearly~~ **(Strike out which is not applicable)**
8	Status	Revised/~~New~~ **(Strike out which is not applicable)**
9	To be implemented from Academic Year	From Academic Year: 2022-2023

Date: Signature :

Name: Dr. Anuradha Majumdar
Dean, Science and Technology

Dr. Archana Rath
Chairperson Ad-hoc BoS in Biotechnology

F.Y.B.Sc. Biotechnology (USBT) Course Structure

Semester II

Course code	Course Type	Title	Credits	Nos of Lectures /week
USBT101	Core Subject	Fundamentals of Biotechnology-II	2	3
USBT102	Core Subject	Cell biology and Microbiology-II	2	3
USBT103	Core Subject	Basic Chemistry-II	2	3
USBT104	Core Subject	Biochemistry: Concept of Biomolecules-II and Basic analytical techniques	2	3
USBT105	Core Subject	Physiology and Immunology	2	3
USBT106	Core Subject	Basic Computers and Biostatistics	2	3
USBT107	Ability enhancement course	Ability enhancement course - Sustainable development and Environmental biotechnology	2	3
USBTP101	Core Subject practicals	Practicals of USBT201 & USBT202	2	3
USBTP102	Core Subject practicals	Practicals of USBT203 & USBT204	2	3
USBTP103	Core Subject practicals	Practicals of USBT205 & USBT206	2	3
	TOTAL		20	

Teaching pattern:

One (01) Credit would be of thirty to forty (30-40) learning hours; of this, more than fifty per cent of the time will be spent on classroom 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 (45 Lectures as classroom 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.

EVALUATION SCHEME

The performance of the learners shall be evaluated into TWO Parts.

1. Internal Assessment with 25 marks
2. Semester End Examinations with 75 marks.

Practical Training will have Practical Examination for 100 marks per practical paper at the end of Semester.

The allocation of marks for the Internal Assessment and Semester End Examinations are as follows: -

For Core subjects:

A. Internal Exam-25 Marks
   i. Test/Assignment/Project/Presentation– 20 Marks
   ii. Activities and Attendance - 5 Marks
B. Semester End Examination - 75 Marks
C. Practical Examination – 300 marks (100 marks x 3 core practical papers)

For Ability Enhancement Course:

A. Internal Exam-25 Marks
   i. Assignment/Project/Presentation – 20 Marks
   ii. Activities and Attendance - 5 Marks
B. Semester End Examination- 75 Marks

SEMESTER I

Course Code	Title	Credits	No of lectures
USBT101	Fundamentals of biotechnology-1	02	

Course Objectives:
To familiarize the students with the potential and different applications of biotechnology

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

- Develop an understanding of developments in various fields of Biotechnology
- Be able to relate to applications and benefits of Biotechnology in the fields of agriculture, livestock, human health and environment
- Discuss the basics of fermentation

Unit I- Introduction and scope of biotechnology	**What is biotechnology?** Biotechnology –an interdisciplinary biological science; Biotechnology – definition; History & Introduction to Biotechnology; Traditional and Modern Biotechnology; Scope and importance of biotechnology; **World of Biotechnology-** Pharmaceutical Biotechnology, Plant Biotechnology, Industrial Biotechnology, Marine Biotechnology, Animal Biotechnology, Medical biotechnology, Environmental Biotechnology. **Biotechnology in India** – Bio-business in India, booming biotech market, success story of biotech market, policy initiatives; and global trends; Biotechnology research in India; **Potential of modern biotechnology;** Achievement of biotechnology; Prevention of misuse of biotechnology; Biotechnology Institutions in India (Public and Private Sector); Public Perception of Biotechnology. **Case study: Serum Institute of India and its products**		15
Unit II- Applications of biotechnology	**Applications of biotechnology: -** **Agriculture:** GM fruits- GM papaya, GM tomato, Insect resistant transgenic plants – Bt cotton, Bt brinjal, Modifications in nutrient quality – starch, oilseed protein, golden rice **Livestock:** Growth, disease resistance, product quality, pharmaceuticals and nutritional supplements, industrial applications		15

	Human welfare: Cloned genes for production of -Insulin; recombinant vaccine for Hepatitis B virus. Molecular farming, Edible vaccines and their advantages **Environment-** Pollution abatement through GMOs **Bioethics** **Case study:** Genetically modified microbes for bioremediation of oil spills in marine environment		
Unit III-Fermentation technology	**Introduction to fermentation processes:** Microbial biomass, Microbial enzymes, Microbial metabolites, recombinant products, transformation processes. Development of fermentation Industry **Component parts of fermentation process** **Screening:** Definition, Primary screening and its methods, Secondary screening and its methods **Fermenter design:** Definition of a fermenter, aerated stirred tank batch fermenter-Typical design, Construction materials used, aeration and agitation **Basic introduction to process parameters:** Temperature control, Foam production and control pH measurement and control, CO2 and O2 control **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 **Product: A typical process of Ethanol production and Antibiotic production**		**15**
References	1. Dubey, R. C. (1993). A textbook of Biotechnology. S. Chand Publishing. 2. Dubey, R. C. (2014). Advanced biotechnology. S. Chand Publishing. 3. Singh, B. D., & Singh, B. D. (2007). Biotechnology expanding horizons. Kalyani publishers. 4. Stanbury, P. F., Whitaker, A., & Hall, S. J. (2013). Principles of fermentation technology. Elsevier. 5. Casida, L. E. (1968). Industrial microbiology. Industrial microbiology. 6. Okafor, N., & Okeke, B. C. (2017). Modern industrial microbiology and biotechnology. CRC Press.		

Course Code	Title	Credits	No of lectures
USBT102	Microbiology-1	02	

Course Objectives:

To build firm foundation in microbiology, sterilization techniques and staining.

Learning Outcomes:

By the end of the course the student will:

- Develop an understanding of cultivation of microorganisms.
- Develop skills towards use of microscopy and staining techniques
- Understand the role of sterilization and disinfection in the field of microbiology

Unit I- Introduction to microbiology	**Fundamentals, History and Evolution of Microbiology:** Discovery of Microorganisms, Conflict over spontaneous generation. Role of microorganisms in disease **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 **Nutrition, Cultivation and Maintenance of microorganisms:** Nutritional categories of microorganisms, Design and Types of Culture Media, methods of isolation.		15
Unit II- Sterilization techniques	**Introduction:** Definition and concept of 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. **Disinfectant:** Ideal Disinfectant. Examples of Disinfectants and Evaluation of Disinfectant		15
Unit III- Microscopy and stains	**Simple and Compound Microscope:** 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** **Applications of microscopes** **Stains and Staining Solutions-** 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.		15

	Natural and Synthetic Dyes. **Simple Staining, Differential Staining – Gram staining and Acid Fast Staining with specific examples**		
References	1. Prescott, L. M. (2002). Microbiology 5th Edition. 2. Pelczar., Microbiology. (1993). India: McGraw-Hill Education. 3. Ananthanarayan, R., Paniker, C. J. (2006). Ananthanarayan and Paniker's Textbook of Microbiology. India: Orient Longman. 4. Salle, A. J., & Salle, A. J. (1954). Fundamental principles of bacteriology McGraw-Hill. 5. Frobisher M. Fundamentals of Microbiology (9th Ed)		

Course Code	Title	Credits	No of lectures
USBT103	**Basic Chemistry-1**	**02**	

Course Objectives:
To acquaint the students with basic concepts of Chemistry like nomenclature, chemical bonds, titrimetric, gravimetry, stereochemistry etc.

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

- Develop an understanding of chemical bonds.
- Develop skills towards use of titrimetric and gravimetric analysis
- Be able to differentiate between chiral and achiral molecules and different enantiomers

Unit I-Nomenclature and Chemical bonds	**Classification and Systematic Nomenclature of organic compounds** (few examples) **Chemical Bonds:** Types and transition between the main types of bonding. **Ionic Bond:** Nature of Ionic Bond, factors influencing the formation of Ionic Bond. Structure of NaCl and CsCl. **Covalent Bond:** Nature of Covalent Bond, Types of covalent bond (Polar and Coordinate covalent bonds). Structure of CH_4, NH_3, H_2O, Shapes of $BeCl_2$, BF_3. **Hydrogen Bond:** Theory of Hydrogen Bonding and Types of Hydrogen Bonding (with examples of RCOOH, ROH, Salicylaldehyde, Amides and Polyamides).		**15**

Unit II-Titrimetric and gravimetry	**Titrimetric Analysis:** Titration, Titrant, Titrand, End Point, Equivalence Point, Titration Error, Indicator, Primary and Secondary Standards, Characteristics and examples. Types of Titrations – Acid –Base, Redox. Precipitation, Complexometric Titration. Acid – Base Titration - Strong Acid Vs Strong Base. Theoretical aspects of Titration Curve and End Point Evaluation. Theory of Acid –Base Indicators, Choice and Suitability of Indicators. **Gravimetric Analysis:** Solubility and Precipitation, Factors affecting Solubility, Nucleation, Particle Size, Crystal Growth, Colloidal State, Ageing/Digestion of Precipitate. Co-Precipitation and Post-Precipitation. Washing, Drying and Ignition of Precipitate.		**15**
Unit III-Stereochemistry	**Isomerism:** Types of Isomerism: Constitutional Isomerism (Chain, Position and Functional) and Stereoisomerism, Chirality. **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) **Conformation:** Conformations of Ethane. Difference between Configuration and Conformation. **Configuration:** Asymmetric Carbon Atom, Stereogenic/ Chiral Centers, Chirality Representation of Configuration by —Flying Wedge Formula **Projection formulae:** Fischer, Newman and Sawhorse. The Interconversion of the Formulae.		**15**
References	1. Bahl, B. S., & Bahl, A. (2017). A textbook of organic chemistry. S. Chand Publishing. 2. Lee, J. D. (2008). Concise inorganic chemistry. John Wiley & Sons. 3. Skoog, D. A., West, D. M., Holler, F. J., & Crouch, S. R. (2013). Fundamentals of analytical chemistry. Cengage learning. 4. Vogel, A. I., & Jeffery, G. H. (1989). Vogel's textbook of quantitative chemical analysis. Wiley. 5. Mosher, M. (1992). Organic Chemistry. (Morrison, Robert Thornton; Boyd, Robert Neilson).		

Course Code	Title	Credits	No of lectures
USBT104	Biochemistry: Concept of Biomolecules-I	02	

Course Objectives:
To acquaint the students with different concepts of biomolecules
Learning Outcomes:
By the end of the course the student will:

- Develop skills towards preparation of standard solutions in the laboratory.
- Understand the role of buffers
- Discuss the basics of carbohydrate and lipid biochemistry.

Unit I- Water, Standard solutions and Buffers	**Structure, Properties and functions:** 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. **Concept of pH:** Buffer solutions –Concept of Buffers, Derivation of Henderson -Hasselbach equation for Acidic and Basic buffers. Buffering capacity **Biological buffers:** Significance of biological buffers. pH of body fluids like blood and saliva. Blood buffer systems: E.g.: Carbonate, Acetate and Phosphate buffers.Protein buffers (Introduction) Significance of TRIS buffers (Introduction)		15
Unit II- Basics of Carbohydrate Chemistry	**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. **Biologically important Derivatives of Hexoses:** Glucosamine, Gluconic acid, uronic acid, NAGA, NAMA **Chemical reactions of monosaccharides** **Concept of glycosidic bond.** **Disaccharides:** Maltose, Lactose, Sucrose, Cellobiose (structures to be taught, biological significance, structure and bond type) **Polysaccharides:** Homopolysaccharides and Heteropolysaccharides; Structural		15

	and Storage Polysaccharides. E.g., of polysaccharides -: starch (amylose and amylopectin), Glycogen, Peptidoglycan, Cellulose, chitin (structure and bond type) **Examples of Reducing and nonreducing carbohydrates.** **Industrial applications of carbohydrates:** Fermentation, Pharmaceutical and Food industry.		
Unit III- Basics of Lipid Chemistry	**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) **Unsaturated Fatty Acids:** Definition of MUFA and PUFA. C16- C20. Palmitolic, Oleic, Linoleic, Lenolenic, Arachidonic acid (Structures expected) **Storage Lipids:** AcylGlycerols (Simple and Mixed) Mono, Di and Triacylglycerols. (Structures expected) **Properties of Triacylglycerols:** Hydrolysis, Saponification, Antioxidant, Rancidity, Acid number, RM number, Action of lipase. **Structural lipids:** Phosphatidic acid and Membrane Phospholipids E.g.: Phosphatidylethanolamine, Phosphatidylserine, Phosphatidylcholine, Cardiolipin **Action of Phospholipase** **Steroids:** Definition and functions Eg: Cholesterol		**15**
References	1. Cox, M. M., & Nelson, D. L. (2008). Lehninger principles of biochemistry (Vol. 5). New York: Wh Freeman. 2. Conn, E., & Stumpf, P. (2009). Outlines of biochemistry. John Wiley & Sons. 3. Satyanarayana U. and Chakrapani U. (2007). Biochemistry. 3rd Edition. Books and Allied (P) Ltd. 4. Mu, P., & Plummer, D. T. (2001). Introduction to practical biochemistry. Tata McGraw-Hill Education.		

Course Code	Title	Credits	No of lectures
USBT105	**Genetics**	**2**	

Course Objectives:
To provide insight to students on fundamental concepts of mendelian genetics, microbial genetics and population genetics
Learning Outcomes:
By the end of the course the student will:

• Develop an understanding of fundamental concepts of mendelian genetics • Discuss the different processes in microbial genetics and their role in mapping genes • Understand the relevance of population genetics			
Unit 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. **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. **Mendelian Genetics in Humans:** Pedigree Analysis. Examples of Human Genetic Traits		**15**
Unit II- Microbial genetics	**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** **Genetic mapping in Bacteria by Transduction:** Bacteriophages - Lytic and Lysogenic pathway. Transduction Mapping of Bacterial Chromosomes - Generalized Transduction and Specialized Transduction.		**15**
Unit III- Population genetics	**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**		**15**
References	1. Russell, P. J., & Gordey, K. (2002). IGenetics ,San Francisco: Benjamin Cummings. 2. Verma, P. S., & Agarwal, V. K. (2004). Cell Biology, Genetics, Molecular Biology,		

Evolution and Ecology: Evoloution and Ecology. S. Chand Publishing.
3. Simmons, M. J., & Snustad, D. P. (2006). Principles of genetics. John Wiley & Sons.
4. Russell, P. J. (2000). Fundamentals of genetics. Longman Publishing Group.
5. Karp, G. (2009). Cell and molecular biology: concepts and experiments. John Wiley & Sons.
6. Strickberger M., Genetics. (1995). Australia: Deakin University.

Course Code	Title	Credits	No of lectures
USBT106	**Molecular biology-I**	**02**	

Course Objectives:
To build a firm foundation of molecular biology
Learning Outcomes:
By the end of the course the student will:

- Develop an understanding of structure and organization of the hereditary material
- Discuss the different processes involved in replication of DNA
- Understand the relevance of physical, chemical and biological factors in mutations

Unit I- Chromosome structure, composition 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**		**15**
Unit II- DNA replication	Models of DNA Replication Evidence of Semi-conservative DNA replication- Messelhson and Stahl's experiment DNA Polymerases and its role, **DNA Replication in Prokaryotes:** *E.coli* Chromosome Replication, Semi-discontinuous replication Bidirectional Replication of Circular DNA molecules. Rolling Circle Replication,		**15**

	DNA Replication in Eukaryotes **Enzymes and proteins involved in DNA replication**		
Unit III-Mutation and repair	**Definition and concept 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**
References	1. Satyanarayana U. and Chakrapani U. (2007). Biochemistry. 3rd Edition. Books and Allied (P) Ltd. 2. Russell, P. J., & Gordey, K. (2002). IGenetics ,San Francisco: Benjamin Cummings. 3. Simmons, M. J., & Snustad, D. P. (2006). Principles of genetics. John Wiley & Sons. 4. Russell, P. J. (2000). Fundamentals of genetics. Longman Publishing Group. 5. Karp, G. (2009). Cell and molecular biology: concepts and experiments. John Wiley & Sons. 6. Strickberger M., Genetics. (1995). Australia: Deakin University		

Course Code	**Title**	**Credits**	**No of lectures**
USBT107	**Ability Enhancement Course-Communication skills**	**02**	

Course Objectives:
To acquaint the students with different aspects of communication skills.
Learning Outcomes:
By the end of the course the student will:

- Develop an understanding of communication skills required to excel in real work environment and corporate life.
- Gain insight into technical and non-technical qualities in career planning
- Learn about Leadership, team building, decision making and stress management

Unit I-Academic skills	**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		**15**

	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		
Unit II- **Soft skills**	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		**15**
Unit III- **Professional skills**	**Creativity at Workplace**: Introduction, Current Workplaces, Creativity, Motivation, Nurturing Hobbies at Work, The Six Thinking Hat Method **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 **Capacity Building**: Need and Importance of Capacity Building Elements of Capacity Building Zones of Learning Ideas for Learning Strategies for Capacity Building **Leadership and Team Building**: Leader and Leadership, Leadership Traits, Culture and Leadership, Leadership Styles and Trends, Team Building, Types of Teams **Decision Making and Negotiation**: Introduction to Decision Making, Steps for Decision Making, Decision Making Techniques, Negotiation Fundamentals, Negotiation Styles, Major Negotiation Concepts **Stress and Time Management**: Stress, Sources of Stress, Ways to Cope with Stress		**15**
References	1. Kumar, Sanjay, and Lata, Pushp. Communication Skills, Second Edition. India, Oxford University Press, 2015. 2. Chauhan, G. S., Sharma, S. (2016). Soft Skills: An Intergrated Approach to Maximise Personality. India: Wiley. 3. Mitra, B. K. (2011). Personality development and soft skills (Vol. 156). Oxford University Press.		

4. Guffey, M. E., & Loewy, D. (2012). Essentials of business communication. Cengage Learning.
5. Rao, M. S. (2010). Soft skills-enhancing employability: connecting campus with corporate. IK International Pvt Ltd.
6. Sherfield, R. M. (2009). Cornerstone: Developing Soft Skills. Pearson Education India.

Course Code	Title	Credits	Notional hours
USBTP101	Practicals of USBT101 and USBT102	2	45

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. Monochrome staining using any suitable material. (Bacteria/Plant/Animal tissue)
6. Differential staining – Gram staining, Acid fast staining, Romanowsky staining.
7. Special staining – cell wall, capsule, spores, negative staining.
8. Fungal staining – wet mount (Lactophenol cotton blue/Methylene Blue)
9. Preparation of media- Nutrient broth and Agar, MacConkey Agar, Sabouraud's Agar
10. Sterilization of Laboratory Glassware and Media using Autoclave and Hot air oven
11. Isolation techniques: T-streak, polygon method
12. Colony Characteristics of Microorganisms.
13. Use of Bergey's manual to help identify any one isolate
14. Isolation of Yeasts from natural environment.
15. Study of morphology and colony characteristics of yeasts
16. Fermentation of Sugarcane juice using yeast.
17. Estimation of sugars by Cole's ferricyanide method.
18. Estimation of Alcohol by dichromate method
19. Screening of antibiotic producers from soil by Crowded plate method.
20. Screening of antibiotic producers from soil by Wilkins Overlay method.

Course Code	Title	Credits	Notional hours
USBTP102	Practicals of USBT103 and USBT104	2	45

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. Iodine value of Oil
11. Determine the rate constant for the saponification reaction between ethyl acetate and NaOH by back titration method
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 $NaHCO_3 + Na_2CO_3$ in the given solid mixture Titrimetrcially.
15. Determination of the amount of Mg (II) present in the given solution complexometrically.
16. Determination of percent composition of $BaSO_4$ and NH_4Cl 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	Title	Credits	Notional hours
USBTP103	**Practicals of USBT105 and USBT106**	**2**	**45**

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 *Allium cepa* 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 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, PTC tasting etc.)
20. Study of blood groups ABO in humans

SEMESTER II

Course Code	Title	Credits	No of lectures
USBT201	**Fundamentals of Biotechnology-II**	**02**	
Course Objectives: To acquaint students with the applications of biotechnology in the field of food, medicine and fermentation **Learning Outcomes:** By the end of the course the student will: • Develop an understanding of the application of biotechnology in the food industry. • Gain insight into details of genetic engineering. • Discuss tools and techniques used in medical biotechnology			
Unit I- **Food Biotechnology**	**Introduction to food biotechnology:** History of microorganisms in food science and key developments, Applications of biotechnology in fermented food products **Introduction to Unit Operations and Processes:** Basic unit operations, food processing & packaging (canning & bottling), Production of cultures **Fermented food products:** Bread, Vinegar, Sauerkraut, Single Cell Protein (SCP), Probiotics **Food spoilage, food deterioration, food contamination and Food Adulteration** **Methods of food preservation** **Indicators of Food Microbial Quality & Safety:** HACCP, FSSAI & FDA		**15**

Unit II- Medical biotechnology	**Introduction to Medical Biotechnology and its applications** **Vaccines** Types of vaccines General vaccine production Large scale production of vaccine Trends in Vaccines Research Issues related to vaccine research **Synthetic peptides as vaccine** **Antibody Production** **Gene therapy** **Organ transplant cloning** **Stem cells -Sources and applications**		**15**
Unit III- Genetic engineering	**What is Genetic engineering:** Definition and developments 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, Introducing insert into cloning vector **Enzymes in genetic engineering:** Restriction endonuclease; 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 **Host cells:** *E. coli; Bacillus subtilis; Saccharomyces cerevisiae*; Xenopus oocytes; Mammalian fertilized egg cell **Introducing vector into host:** Prokaryote Eukaryote **Identification of recombinant clones.**		**15**
References	1. Frazier, W. C., & Westhoff, D. C. (1983). Food microbiology 5th Ed. 2. Lee, B. H. (2014). Fundamentals of food biotechnology. John Wiley & Sons. 3. Jay, J. M., Loessner, M. J., & Golden, D. A. (2008). Modern food microbiology. Springer Science & Business Media. 4. Woolverton, C. J., Sherwood, L., Willey, J. (2014). Prescott's Microbiology. India: McGraw-Hill Education. 5. Patel, A. H. (1984). Industrial Microbiology. Macmillan India. 6. Khan, F. A. (2011). Biotechnology fundamentals. CRC Press.		

	7. Nicholl, D. S. T. (2002). An Introduction to Genetic Engineering (Studies in Biology). India: Cambridge University Press. 8. Brown, T. A. (2013). Gene Cloning and DNA Analysis: An Introduction. Germany: Wiley. 9. Genetic Engineering: Principles and Practice. (n.d.). India: McGraw-Hill Education. 10. A Textbook of Biotechnology by R C Dubey 4th Ed 11. Dubey, R. C. (2014). Advanced biotechnology. S. Chand Publishing

Course Code	Title	Credits	No of lectures
USBT202	**Cell biology and Microbiology-II**	**02**	

Course Objectives:
To build a firm foundation of concepts related to cell biology and microbiology
Learning Outcomes:
By the end of the course the student will:

- Discuss the ultrastructure, function and location of organelles in prokaryotic and eukaryotic cells.
- Develop an understanding of microbial growth and enumeration
- Gain insight in to the basics of virology

Unit I- Ultrastructure of prokaryotic and eukaryotic cell	**Ultrastructure of Prokaryotic Cell:** Concept of Cell shape, size and arrangement **Bacterial structures external to cell wall:** Flagella, Pilli, Fimbriae, Capsule, Slime Layer, Sheath **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 **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. **External Cell Coverings:** Cilia and Flagella **Comparison of Prokaryotic and Eukaryotic Cells**		15

Unit II-Microbiology	**Microbial Growth** 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 Methods **Preservation and Maintenance of cultures**		**15**
Unit III-Virology	**Introduction to virology:** Historical perspective, **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 **Case studies-** TMV, Influenza COVID-19 (Self learning)		**15**
References	1. Pelczar., Microbiology. (1993). India: McGraw-Hill Education. 2. Verma, P. S., & Agarwal, V. K. (2004). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology: Evolution and Ecology. S. Chand Publishing. 3. Dubey, R. C. (2014). Advanced biotechnology. S. Chand Publishing 4. Cooper, G. M., Hausman, R. E., & Hausman, R. E. (2007). The cell: a molecular approach (Vol. 4). Washington, DC: ASM press. 5. Stanier, R. Y. (1987). General Microbiology. Hong Kong: Macmillan. 6. Funke, B. R., Case, C. L., Tortora, G. J. (2013). Microbiology: An Introduction. United Kingdom: Pearson. 7. Woolverton, C. J., Sherwood, L., Willey, J. (2014). Prescott's Microbiology. India: McGraw-Hill Education		

Course Code	Title	Credits	No of lectures
USBT203	**Basic Chemistry-II**	**02**	

Course Objectives:
To acquaint the students with some core aspects of physical chemistry
Learning Outcomes:
By the end of the course the student will:

- Develop an understanding of thermodynamics
- Learn about reaction kinetics and order of reaction

• Gain insight in to the details of oxidation and reduction reactions			
Unit I- Thermodynamics	**Thermodynamics:** System, Surrounding, Boundaries Sign Conventions, State Functions, Internal Energy and Enthalpy: Significance, examples, (Numericals expected.) **Laws of Thermodynamics and its Limitations:** Mathematical expression. Qualitative discussion of Carnot Cycle for ideal Gas and Mechanical Efficiency. Laws of Thermodynamics as applied to Biochemical Systems. **Concept of Entropy, Entropy for Isobaric, Isochoric and Isothermal Processes.**		**15**
Unit II- Chemical Kinetics	**Reaction Kinetics:** Rate of Reaction, Rate Constant, Measurement of Reaction Rates Order & Molecularity of Reaction, Integrated Rate Equation of First and Second order reactions (with equal initial concentration of reactants). (Numericals expected) **Determination of Order of Reaction:** a) Integration Method b) Graphical Method c) Ostwald's Isolation Method d) Half Time Method. (Numericals expected).		**15**
Unit III- Oxidation Reduction reactions	**Principles of Oxidation & Reduction Reactions:** Oxidising and Reducing Agents Oxidation Number, Rules to assign Oxidation Numbers with examples Ions like Oxalate, Permanganate and Dichromate. **Balancing Redox Reactions:** Ion Electron Method Oxidation, Reduction, Addition and Substitution & Elimination Reactions.		**15**
References	1. Rao, C. N. R. (1973). University General Chemistry : An Introduction To Chemical Science. India: Macmillan India Limited. 2. Chang, R. (2000). Physical Chemistry for the Chemical and Biological Sciences. United Kingdom: University Science Books. 3. Lee, J.D., Concise Inorganic Chemistry, 5TH ED. (2008). India: Wiley India Pvt. Limited. 4. Bajpai, D. N. (2001). Advanced Physical Chemistry. India: S. Chand, Limited. 5. Singh, A. K., Singh, N. B., Das, S. S. (2009). Physical Chemistry: Volume II. India: New Age International.		

Course Code	Title	Credits	No of lectures

USBT204	Biochemistry: Concept of Biomolecules-II and Basic analytical techniques	02	

Course Objectives:
To build a firm foundation on the fundamentals of biochemistry and analytical techniques
Learning Outcomes:
By the end of the course the student will:

- Learn about fundamental structures and functions of amino acids & proteins.
- Develop an understanding of protein biochemistry and enzymology.
- Develop skills towards the principle, working and applications of different analytical techniques.

Unit I- Proteins and amino acids	**Amino acids:** General introduction, Classification and structures, properties (physical & chemical) Amino Acids as drugs. Titration Curve of Amino Acids. Concept of Isoelectric pH, Zwitterion **Reactions of Amino Acids:** Sorenson's Titration, Ninhydrin Test **Proteins:** Introduction, definition and functional classification. **Classification of Proteins:** Simple- Fibrous and Globular Conjugated- Nucleoprotein, Lipoprotein, Glycoprotein, Phosphoprotein, Chromoprotein, Metalloprotein Derived- Primary and Secondary **Peptide bond:** Features Example of Dipeptide, tripeptide,Nonapeptide e.g., Oxytocin, Vasopressin Amino acid composition of Bovine Cytochrome C and Bovine Chymotrypsinogen **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 E.g., structure of human Insulin **Properties of proteins:** Solubility, Molecular weight, Shape, Iso electric pH, Salting out of proteins for purification **Protein Denaturation and folding:** Denaturing agents and properties of denatured proteins		15
Unit II- Enzymes	**Introduction to biocatalysis:** Properties of Enzymes Substrate, Optimum conditions, Co-substrate, Coenzyme, Cofactors **Classification and Nomenclature** (one reaction per		15

	class) Mechanism of Enzyme Action, Active Sites, Enzyme Specificity, **Factors affecting enzyme activity** (Effect of pH, Temperature, Substrate Concentration, Enzyme concentration) **Enzyme Kinetics:** Derivation of Michaelis-Menten Equation, Lineweaver-Burk plot, Concept of km **Types of Enzyme Inhibitions:** Irreversible & Reversible (Competitive, Uncompetitive, Non-Competitive) **Isoenzymes** (LDH, Alkaline Phosphatase, Creatine Phosphokinase) Allosteric Modulators, Co-Factors, Zymogens, Enzyme units Enzymes as Biomarkers and diagnostic tools. (SGPT, SGOT, LDH, CPK) **Industrial Applications of Enzymes**		
Unit III- Basics of Analytical techniques	**Methods of Separation:** Precipitation, Filtration, Distillation and Solvent Extraction **Analytical Techniques** **Chromatography:** Definition, Principles, Chromatographic performance parameters, Types Paper Chromatography, Thin Layer Chromatography, Column Chromatography (Principle and Applications) **Spectroscopy - Colorimetry:** Properties of electromagnetic radiation, interaction with matter, lasers 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 **Electrophoresis:** General principles, Factors affecting electrophoresis, Types of support media used, Types of electrophoresis (Agarose gel electrophoresis, PAGE)		**15**
References	1. Cox, M. M., & Nelson, D. L. (2008). Lehninger principles of biochemistry (Vol. 5). New York: Wh Freeman. 2. Conn, E., & Stumpf, P. (2009). Outlines of biochemistry. John Wiley & Sons. 3. Satyanarayana U. and Chakrapani U. (2007). Biochemistry. 3rd Edition. Books and Allied (P) Ltd. 4. Jain, J. L. (2004). Fundamentals of Biochemistry. India: S. Chand Limited. 5. Skoog, D. A., West, D. M., Holler, F. J., Crouch, S. R. (2014). Fundamentals of Analytical Chemistry. India: Brooks/Cole, Cengage Learning. 6. Principles and Techniques of Biochemistry and Molecular Biology. (2010). United States: Cambridge University Press.		

Course Code	Title	Credits	No of lectures
USBT205	**Physiology and immunology**	02	

Course Objectives:
To provide an insight in to the different physiological processes of plants and animals.
Learning Outcomes
By the end of the course the student will:

- Gain insights into the Physiological Processes of Plants and functions of plant growth regulators.
- Develop a comprehensive and deep understanding of the vital physiological processes of animals.
- Understand the concept of immunity and role of antigens and immunoglobulins in the immune system.

Unit I- Plant Physiology	**Photosynthesis:** Hill's Reaction and its Significance, Light Reactions, Cyclic and Non-Cyclic Photoinduced 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, Abscisic acid **Introduction to Secondary Metabolites**		15
Unit 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. Coagulation of blood. Theories of Coagulation. Haemolysis. **Respiratory system:** Phases of Respiration, Principle of gases exchange, Mechanism of breathing. **Digestion and absorption:** Mode of nutrition, Digestion: Digestion of foodstuffs, Digestion in humans. Absorption. **Excretion:** Organs of excretion. Types of excretory products. Excretion in vertebrates - Human **Kidney:** Structure of kidney, Structure of nephron. Function of kidney. Urine formation. Dialysis		15

Unit III-Immunology	**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.		**15**

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1. Cox, M. M., & Nelson, D. L. (2008). Lehninger principles of biochemistry (Vol. 5). New York: Wh Freeman.
2. Verma, S. K., Verma, M. (2008). A Textbook of Plant Physiology, Biochemistry and Biotechnology. India: S. Chand Limited.
3. Gujral, S. K., Kochhar, S. L. (2020). Plant Physiology: Theory and Applications. United States: Cambridge University Press.
4. Rastogi, S. C. (2007). Essentials of Animal Physiology. India: New Age International (P) Limited, Publishers.
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6. Sembulingam, K. (2008). Essentials of Medical Physiology. India: Juta, Limited.
7. Sherwood, L. (2012). Introduction to Human Physiology. United States: Brooks/Cole.
8. Goldsby, U. R. A., Kuby, J., Kindt, T. J., Goldsby, R. A., Osborne, B. A., Marcus, D. A. (2003). Immunology. United Kingdom: W. H. Freeman.
9. Textbook Of Microbiology (7th Edition). (2006). India: Orient BlackSwan.
10. Rao, C. V. (2017). Immunology. United Kingdom: Alpha Science International, Limited.
11. Murphy, K. M., Weaver, C. (2017). Janeway's Immunobiology. United Kingdom: Garland Science/Taylor & Francis Group, LLC.

Course Code	Title	Credits	No of lectures
USBT206	**Basic Computers and Biostatistics**	**02**	

Course Objectives:
To develop the students' understanding of computer and biostatistics
Learning Outcomes:
By the end of the course the student will:

- Develop an understanding of computer networking and internet
- Develop skills to use word processing, spreadsheet, presentation software.
- Gain insights about the use of statistics in the field of biotechnology

Unit I-	**Introduction to computers:**		**15**

Introduction to computers	Overview and functions of a computer system, Input and output devices, Storage devices. Modern computers: The workstation, The Minicomputer, Mainframe Computers, Parallel processing Computer & The Super Computer **Introduction to operating systems:** Operating System concept, Windows, Unix/Linux & servers **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 **Presentation Graphics:** Creating and Editing Presentations, Designing and Enhancing Presentation, Delivering Presentation, Advanced Presentation Graphics.		
Unit II-Computer networking	**Introduction to networking:** Various terminologies Associated hardware devices, gadgets (Router, Switch) tools, services, and resources Network Topologies and Protocols, LAN, WAN and MAN World Wide Web (WWW) Network security: fire walls **Computer viruses:** An overview of Computer viruses: What is a virus? Virus signs, how do they get transmitted? What are the dangers? General Precautions **The Internet and Internet Services:** Introduction, History of Internet, Internetworking Protocol, The Internet 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 Internet Address Internet Services: World Wide Web (WWW), Web Browser, Uniform Resource Locator (URL) Internet Search Engines, WWW Development Languages, Uses of Internet **Electronic Mail:** E-mail Address, E-mail Message Format, E-mail Services, How E-mail Works File Transfer Protocol (FTP), How FTP Works, Terminal Network (Telnet), News, Internet Relay Chat (IRC), MS Outlook.		**15**
Unit III-Biostatistics	**Introduction to Biostatistics:** Definition & Importance of Statistics in Biology Variables, Types of variables (Quantitative & Qualitative) **Types of Data and data visualization:**		**15**

	Concept of 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) **Sampling strategies:** 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 **Types of Statistics:** Introduction to Descriptive & Inferential statistics **Descriptive statistics:** **Measures of central tendency:** Mean, Mode, Median (Ungrouped & Grouped data) **Measures of dispersion:** Range, Variance, Standard deviation (Ungrouped & Grouped data), Coefficient of variation **Measures of location:** Percentiles, Interquartile range (Box-Whisker plot) **Normal/Gaussian distribution, Standard normal deviate, Sampling variation, Standard error of mean**		
References	1. Sinha, P. K., Sinha, P. (2004). Computer Fundamentals. India: BPB Publications. 2. Goel, A. (2010). Computer Fundamentals. India: Pearson Education. 3. Wempen, F. (2014). Computing Fundamentals: Introduction to Computers. Germany: Wiley. 4. Tanenbaum, A. S., Wetherall, D. (2014). Computer Networks. United Kingdom: Pearson Education. 5. Khanal, A. B. (2015). Mahajan's Methods in Biostatistics For Medical Students and Research Workers. India: Jaypee Brothers,Medical Publishers Pvt. Limited. 6. Cross, C. L., Daniel, W. W. (2018). Biostatistics: A Foundation for Analysis in the Health Sciences. United Kingdom: Wiley. 7. Arora, P. N., Malhan, P. K. (2009). Biostatistics. India: Himalaya Publishing House.		

Course Code	Title	Credits	No of lectures
USBT207	**Ability Enhancement Course- Sustainable development and Environmental biotechnology**	**02**	

Course Objectives:
To sensitize and create awareness about Ecology, renewable energy and different Environmental Issues.
Learning Outcomes:
By the end of the course the student will:

- Develop an understanding of the structure and functioning of the ecosystems.
- Gain insights about the concept of pollution, climate change and sustainable development

• Understand the relevance of renewable energy sources and conservation of biodiversity			
Unit I- Ecological interactions and Biodiversity	**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, Different Abiotic Factors of ecosystem and adaptations to different abiotic factors **Ecological 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, threats to biodiversity, conservation of biodiversity		**15**
Unit II- Pollution and climate change	**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.** **Sustainable development:** Concept, basic principles of sustainable development, post-brundtland world, roots of sustainability, Indicators, paradigm towards new discipline-sustainability science.		**15**
Unit III- Renewable sources of energy	**Introduction:** Renewable and Non-renewable resources. The need for a sustainable lifestyle. **Energy resources:** Types of energy Nonrenewable 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.		**15**

References	1. Verma, V. (2010). Botany. India: Ane Books Pvt Ltd. 2. Bharucha, E. (2005). Textbook of Environmental Studies for Undergraduate Courses. India: Universities Press (India) Pvt. Limited. 3. Verma, P. S. (2004). Cell Biology,Genetics, Molecular Biology: Evoloution and Ecology. India: S. Chand Limited. 4. Khoiyangbam, R. S. (2015). Introduction to Environmental Sciences. India: Energy and Resources Institute. 5. Fulekar, M. H. (2010). Environmental Biotechnology. United Kingdom: CRC Press. 6. Scragg, A. H. (2004). Environmental Biotechnology. United Kingdom: Oxford University Press.

Course Code	Title	Credits
USBTP201	Practicals of USBT201 and USBT202	02

21. Assignment - Write a report on a case study on any one food product developed at CFTRI.
22. 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.
23. Microbial examination of food and detection of Pathogenic Bacteria from Food Samples
24. Microscopic determination of Microbial flora from Yoghurt and Lactic Acid Determination
25. Isolation and characterization of organisms causing Food Spoilage (Using Bergey's Manual)
26. Isolation and characterization of food fermenting organism from idli batter (Using Bergey's Manual)
27. Sauerkraut production and to analyze quality parameters during production (odour, color, pH, total acidity)
28. Determination of food preservative concentration (salt & sugar) using MIC.
29. Processing fruits for preparation and packaging of jams or jellies.
30. Detection of Food adulterants in food samples
31. Isolation of chromosomal DNA from *E. coli* and Agarose gel electrophoresis of the chromosomal DNA
32. 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.
    c. (ϕX174, T4,3) using electron micrographs/diagrams.
33. Isolation and enumeration of bacteriophages (PFU) from water/sewage sample using double agar layer technique.
34. Motility by hanging drop method/stab culture
35. Methods of preservation of culture
36. Study of Growth Curve of *E.coli*
37. Preparation of vaccine (Demonstration) and Sterility testing of Vaccine
38. Enumeration by Breed's count
39. Isolation and Enumeration of microorganisms- Serial dilution, Surface spread method,
40. Isolation and Enumeration of microorganisms- Serial dilution, Pour plate method.

Course Code	Title	Credits
USBTP202	Practicals of USBT203 and USBT204	02

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 K 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
    a. Plants Pigments
    b. 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 Vmax and Km
17. Study of Effect of inhibitors on amylase enzyme activity
18. Determination of absorption maxima of CuSO4/ K2Cr2O7
19. Verification of Beer and Lambert's Law
20. Estimation of Protein by Biuret method

Course Code	Title	Credits
USBTP203	**Practicals of USBT205 and USBT206**	**2**

1. Study of Hill's reaction
2. To measure the rate of photosynthesis by Winkler's method
3. Effect of PGRs 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
13. Study of bacterial flora of skin (as a physical barrier in innate immunity) by swab method/Hand imprint method.
14. File handling: copy, rename, delete, type and Directory structure: make, rename, move directory
15. Word Processing:
    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),
e. Working with Graphics (Word Art), Working with Tables & Charts, Inserting Files (Pictures, Databases, Spreadsheets)

16. Spreadsheet Applications:
    a. Worksheet Basics: Entering information in a Worksheet, Saving & Opening a Worksheet, Editing, Copying & Moving data, Inserting, Deleting & Moving Columns & Rows, Clearing
    b. Using formulas in spreadsheet for simple calculations
    c. Creating graphs, pie charts etc in
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, wordart, textbox.
    c. Assigning Transitions and animations 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)

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	kill 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		

Course objectives:-

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

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

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

UNIT I **Optics and Electromagnetic Radiations**	**Introduction to Optics and Lasers:** ***Optics* :** Properties of Light - Reflection, Refraction, Dispersion, Interference. ***Lasers* :** 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.		15	
UNIT II **Heat, Sound, Magnetism and Fluid Dynamics**	**Heat:** Concept of Temperature; Modes of Heat Transfer; Measuring Temperature; Platinum Resistance Thermometer; Thermocouple and Thermistors. **Sound:** Types of Sound Waves - Audible, Ultrasonic and Infrasonic Waves; Doppler Effect; Applications of Ultrasonic Waves. **Magnetism:** Magnetic Field; Magnetism of Earth; Para-magnetism, Diamagnetism, Ferromagnetism. Nuclear Magnetism and Biomagnetism.		15	

	Fluid Dynamics : ***Viscosity*:** Definition Flow of Liquids through Capillaries; Stokes' Law; Terminal Velocity. Determination of 'η' by Falling Sphere Method; Viscosity Estimation by Oswald's Viscometer. ***Surface Tension*:** Definition - Surface Tension and Surface Energy; Capillary Action; Angle of Contact; Wettability; Temperature Dependence of Surface Tension. Applications in Biology.			
UNIT III **Electrophoretic Techniques**	**Electrophoresis:** Migration of Ions in an applied electric field; Factors affecting Electrophoretic Mobility; Moving Boundary Electrophoresis; Principle of Electrophoresis; Supporting Matrix; Paper Electrophoresis; AGE; Native and SDS PAGE (reducing and non-reducing, continuous and discontinuous);IEF and 2D PAGE. Staining and Detection Methods; Gel-Documentation. Applications in Biology.		15	

Course Code	Title	Credits	No. of Lectures	Notional hours
USBT302	**APPLIED CHEMISTRY –I**	**2**		

Course objectives:-

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

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

- Develop an understanding of the different aspects of Organic and Green Chemistry.
- Discuss role of Organic Compounds in Biology and Synthesis of Organic Compounds.
- Discuss role of Green Chemistry and its application in Industry.

UNIT I **Organic Chemistry**	**Introduction to Types of Organic Reactions :** Addition, Elimination and Substitution Reactions. Essential and Non-essential Elements in Biological Systems. Role of Metal Ions in Biological Systems. **Metal Coordination in Biological Systems :** Enzymes, Apoenzymes and Coenzymes. Biological Role of Metalloenzymes *wrt* Myoglobins, Haemoglobin. Biological Role of Carboxypeptidases, Catalases and Peroxidases.		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:

- 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**	**Precipitation Reactions :** Immunoprecipitation, Immunoelectrophoresis, CIEP, Rocket Electrophoresis and 2-D Immunoelectrophoresis. **Agglutination Reactions :** Passive, Reverse Passive, Agglutination Inhibition. Coomb's Test; Complement Fixation Tests, RIA, ELISA, ELISPOT, Chemiluminescence, Western Blot, Immunofluorescence, Flow Cytometry. **Alternatives to Antigen-Antibody Reactions.**		15	

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**	**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.		15	
UNIT II **Cell Membrane**	**Cell Membrane :** Uptake of Nutrients by Prokaryotic Cells; Cell Permeability. Principles of Membrane Transport-Transporters and Channels; Active Transport,		15	

	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. Cellular Interactions.			
UNIT III **Cytogenetics**	**Cytogenetics :** Structure of Chromosome - Heterochromatin, Euchromatin, Polytene Chromosomes. **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. **Sex Determination and Sex Linkage :** Mechanisms of Sex Determination (XX-XY, ZZ-ZW, XX-XO) Dosage Compensation and Barr Body. **Genetic Linkage, Crossing Over and Chromosomal Mapping :** Tetrad Analysis; Two-point Cross; Three-point Cross; Pedigree Analysis.		**15**	

Course Code	Title	Credits	No. of Lectures	Notional hours
USBT305	**MOLECULAR BIOLOGY**	**2**		

Course objectives:-

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

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

- Discuss the mechanisms associated with Gene Expression at the level of Transcription and Translation.
- Discuss the mechanisms associated with Regulation of Gene Expression in Prokaryotes and Eukaryotes

UNIT I **Gene Expression-Transcription**	**Gene Expression- an Overview.** **Transcription Process in Prokaryotes :** RNA Synthesis; Promoters and Enhancers; Initiation of Transcription at Promoters; Elongation and Termination of an RNA Chain. **Transcription in Eukaryotes :** Eukaryotic RNA Polymerases; Eukaryotic Promoters; Transcription of Protein Coding Genes by RNA Polymerase; Eukaryotic mRNA's; Transcription of other genes;		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* :** *lac* Operon of *E.coli*; *trp* Operon of *E.coli*. ***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:

- 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	

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

Course Code	Title	Credits	No. of Lectures	Notional hours
USBT307	**RESEARCH METHODLOGY**	**2**		

Course objectives:-

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

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

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

UNIT I **Introduction to Research Methodology and Research Problem**	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		15	
UNIT II **Research Design and Data Collection**	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		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)	1. Study of Absorption Spectra of Coloured Compounds ($CuSO_4$, $CoCl_2$, $KMnO_4$). 2. Verification of Beer-Lambert's Law. 3. Extraction of Plasmid DNA and Separation by Agarose Gel Electrophoresis. 4. Determination of Purity of Plasmid DNA using UV Spectrophotometry. 5. Study of the Structure and Function of an Electron Microscope (Visit / Video Demonstration - including Sample Preparation and Staining). 6. Demonstration of Structure and Working of a Fluorescence Microscope (Stained Preparation). 7. Electrophoresis of Proteins by PAGE and SDS-PAGE. 8. Purification of any TWO Organic Compounds by Recrystallization Selecting Suitable Solvent. 9. Organic Estimations: Acetone, Amide, Benzoic Acid. 10. Organic Preparations : a) Acetylation of Primary Amine (Preparation of Acetanilide). b) Base Catalysed Aldol Condensation (Synthesis of Dibenzalpropanone).	2
Course code	**Title**	**Credits**
USBTP302 (PRACTICALS based on USBT303 and USBT304)	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

	Translocation and Syndromes- Trisomy 21 Trisomy 13 Trisomy 18, Klinefelter, Turner and Cri-du-Chat. 9. Induction of Polyploidy by PDB Treatment using Suitable Plant Material. 10. Study of Polytene Chromosomes. 11. Mapping based on Tetrad Analysis and Three Point Cross. 12. Pedigree Analysis- Autosomal and Sex-Linked.	
Course code	**Title**	**Credits**
USBTP303 (PRACTICALS based on USBT305 and USBT306)	1. Study of *E.coli* Diauxic Growth Curve- (Lactose and Glucose). 2. Study of *lac* Gene Expression using Blue-White Selection. 3. Expression of β-galactosidase and Measurement of Activity. 4. Screening for an Antibiotic Producing Strain of Microorganism. 5. Screening for an Alcohol Producing Strain of Microorganism. 6. Lab Scale Production of Penicillin (Static and Shaker). 7. Purification of *Penicillin* from Broth Culture of *Penicillium spp.* by Solvent Extraction. 8. Lab Scale Production of Ethanol. 9. Purification of Ethanol from Broth Culture of *Saccharomyces spp.* by Distillation. 10. Estimation of *Penicillin* from Recovered Broth by Chemical (Iodometric) Method. 11. Estimation of *Penicillin* from Recovered Broth by Biological (Bioassay) Method. 12. Estimation of Alcohol from Recovered Broth by Dichromate Method.	2

SEMESTER-IV

Course Code	Title	Credits	No. of Lectures	Notional hours
USBT401	BIOCHEMISTRY	2		

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.

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

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

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

	Nucleotide Metabolism : Degradation of Purines and Pyrimidines.			

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**	**Sampling :** Importance of Sampling and Sampling Techniques Types of Sampling - Random and Non-Random Sampling of Solids, Liquids and Gases. **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.	15	15	
UNIT II **Natural Product Chemistry**	**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. **Chromatographic Separation of Natural Products :** Gas Chromatography and its Applications. Liquid Chromatography : HPLC and its Applications. HPTLC for Separation and Analysis of Natural Products.	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	

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:

- 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 :** *S. aureus, S. pyogenes.* **Respiratory Tract Infections :** *M. tuberculosis, S. pneumoniae*(Characteristics Transmission, Course of Infection, Lab Diagnosis, Management of TB, Prevention and Control, Immuno and Chemoprophylaxis, DOTS and MDR).		15	

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

- 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**	Concept of Bioremediation. Microorganisms in Bioremediation, Myco-remediation and Phytoremediation. Bioremediation Technologies. Measuring Bioremediation in the Field. Bioaugmentation and Biostimulation. Monitoring the Efficacy of Bioremediation.		15	

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

Course objectives:-

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

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

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

UNIT I **Basics of Molecular Diagnostics**	**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. **Characterisation and analysis of Nucleic – Acids and Proteins :** Extraction, Isolation and Detection of DNA, RNA and Proteins; Restriction Endonucleases and Restriction Enzyme Mapping. **Hybridisation Techniques :** Southern, Northern, Western and FISH; Markers, Probes and its Clinical Applications.		15	
UNIT II **Nucleic Acid Amplification Methods**	**Target amplification :** PCR - General Principle; Components of a Typical PCR Reaction; Experimental Design; Primer Designing; Control of PCR Contamination and Mispriming; PCR Product Clean-up and Detection. **PCR Types :** Reverse Transcriptase and Real Time PCR.		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 *Neisseria*, 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:

- 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)	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)	1. Identification of *S.aureus*-Isolation, Catalase, Coagulase Test. 2. Identification of *E.coli*-Isolation, Sugar Fermentations, IMViC. 3. Identification of *Salmonella*- Isolation, Sugar Fermentations, TSI Slant. 4. Identification of *Shigella*- Isolation, Sugar Fermentations, TSI Slant. 5. Identification of *Proteus*- Isolation, Sugar Fermentations, IMViC. 6. Identification of *Pseudomonas* - Isolation, Urease test, Oxidase Test, TSI Slant. 7. RPR Test (Kit Based). 8. Permanent Slide- *Mycobacterium*. 9. Biological Oxygen Demand (BOD). 10. Chemical Oxygen Demand (COD). 11. Isolation of Bacteria from Air by Gravity Sedimentation Method. 12. Most Probable Number (MPN) – Presumptive, Confirmed and Completed Tests.	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.

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EVALUATION PATTERN

The performance of the learner shall be evaluated in TWO parts.
The learner's Performance shall be assessed by Internal Assessment of 25 Marks and Semester End Examination (Theory) of 75 marks for each Term.
Practical Examination will be conducted at end of each Semester for 300 marks

Internal Assessment- 25 Marks

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

Internal Assessment – 25 Marks (General Elective each Semester)
For Course Code USBT 307 (Research Methodology) and USBT 407 (Entrepreneurship Development)

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

Semester end Exam- 75 marks

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

Note:-

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

Practical examination – 300 marks

SEMESTER III

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

SEMESTER IV

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

S4BSc.BT.2023-20

AC – 27/06/2023
Item No. 6.5 (R)

UNIVERSITY OF MUMBAI

Revised Syllabus for

S.Y.B.Sc. (Biotechnology)

(Sem. III & IV)

(CBCS)

(With effect from the academic year 2023-24)

University of Mumbai

Syllabus for Approval

Sr. No.	Heading	Particulars
1	O: _____ Title of Course	S.Y.B.Sc. (Biotechnology)
2	O: _____ Eligibility	As per the University Ordinance O.5106
3	R: _____ Passing Marks	40 %
4	No. of years/Semesters:	3 Years/ 6 Semesters
5	Level:	~~P.G.~~ / U.G./ ~~Diploma~~ / Certificate **(Strike out which is not applicable)**
6	Pattern:	~~Yearly~~ / Semester **(Strike out which is not applicable)**
7	Status:	Revised / ~~New~~ **(Strike out which is not applicable)**
8	To be implemented from Academic Year :	From Academic Year: 2023-24

Prof. Shivram S. Garje,
Dean,
Faculty of Science and Technology

SEMESTER- III				
Course code	**Course type**	**Course Title**	**Credits**	**Lectures/ Week**
USBT301	Core Subject	Bioprocess technology	2	3
USBT302	Core Subject	Medical Microbiology	2	3
USBT303	Core Subject	Applied chemistry-1	2	3
USBT304	Core Subject	Fundamentals in Biophysics	2	3
USBT305	Core Subject	Immunology	2	3
USBT306	Core Subject	Molecular biology-III	2	3
USBT307	General Elective	Biosafety	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 Practicals	Practicals of USBT_305 and USBT_306	2	6
SEMESTER-IV				
Course code	**Course type**	**Course Title**	**Credits**	**Lectures/ Week**
USBT401	Core Subject	Medical biotechnology	2	3
USBT402	Core Subject	Cell biology and cytogenetics	2	3
USBT403	Core Subject	Applied chemistry-2	2	3
USBT404	Core Subject	Biochemistry	2	3
USBT405	Core Subject	Molecular diagnostics	2	3
USBT406	Core Subject	Bioinformatics and Biostatistics	2	3
USBT407	General Elective	Research methodology	2	3
USBTP401	Core Subject	Practicals of USBT_401 and USBT_402	2	6

	Practicals			
USBTP402	Core Subject Practicals	Practicals of USBT_403 and USBT_404	2	6
USBTP403	Core Subject Practicals	Practicals of USBT_405 and USBT_406	2	6

SEMESTER-III

Course Code	Title	Credits	No. of Lectures
USBT301	**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:

- **develop an understanding of the various aspects of bioprocess technology.**
- **develop skills associated with screening of industrially important strains.**
- **understand principles underlying design of fermenter and fermentation process.**

UNIT I **Fermentor design , media and sterilization**	**Fermentor designs:** Air lift fermentor, Tower fermentor,Acetator and cavitator, deep jet, packed Tower **Fermentation Media:** **Media components :** Carbon source-factors affecting choice of Carbon source with examples,Nitrogen source factors affecting choice of Carbon source with examples, Growth factors, Minerals, buffers, minerals, Inducers, precursors Antifoam agents- Types , Properties of Antifoam agent Medium properties: Fast metabolism,Rheology Concept of Inoculum and Production Media Sterilization : Sterilization of Fermentor and Fermentation Media. Sterilization of Media -Batch and Continuous Concept of Del factor Sterilization of Fermentor, feeds, liquid wastes Sterilization of Air Supply, Exhaust gases Filter sterilization		15

UNIT II **Inoculum development and process parameters**	Introduction to Inoculum development; Bacterial and fungal inoculum development with two examples each, scale up, scale down. **Detailed steps in Monitoring and Control of process variables**		15
UNIT III **Fermentation processes-1**	**Types of fermentations and fermentation process** Significance and applications of Batch and continuous, surface and submerged, aerobic and anaerobic, Solid state fermentation. • Industrial products from Microorganisms- Penicillin,semisynthetic penicillin, Streptomycin, Vaccines, hormones • Enzymes and Organic acids from Microorganisms: Ethanol,Citric acid, acetic acid, Lysine, Glutamic acid, Amylases, protease		15

Course Code	Title	Credits	No. of Lectures
USBT302	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:

- **list the factors playing a role in causing a disease gain.**
- **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 **General Bacteriology and Bacteria as Human pathogen, Host parasite interactions**	**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 **Causative organisms-1**	**Skin:** *S. aureus, S. pyogenes.* **Respiratory Tract Infections:** *M. tuberculosis, S. pneumoniae* (Characteristics Transmission, Course of Infection, Lab Diagnosis, Management of TB, Prevention and Control, Immuno and Chemoprophylaxis, DOTS and MDR). **Urinary Tract Infections:** *E.coli* : Characteristics, Virulence, Clinical disease, and *E.coli* Infections.		15

UNIT III **Causative organisms-2**	**GI Tract Infections:** *Salmonella and Shigella* spps. (Characteristics, Virulence- Pathogenesis and Immunity, Clinical Disease, Carriers Lab Diagnosis, Phage Typing Prophylaxis and Treatment). **Sexually Transmitted Diseases :** *Syphilis and Gonorrhoea.* **Nosocomial Infections :** *Ps. aeruginosa*		15

Course Code	Title	Credits	No. of lectures
USBT303	APPLIED CHEMISTRY-1	2	

Course objectives:-

The objective of this course is to have a firm foundation in the fundamentals and applications of organic and green chemistry.

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

- **develop an understanding of the different aspects of organic and green chemistry.**
- **discuss the role of organic compounds in biology and synthesis of organic compounds.**
- **discuss the role of green chemistry and its application in industry.**

Understand the basic concept of electrophoresis

UNIT I Organic chemistry	Introduction to Types of Organic Reactions : Addition, Elimination and Substitution Reactions. Essential and Non-essential Elements in Biological Systems. Role of Metal Ions in Biological Systems. Metal Coordination in Biological Systems : Enzymes, Apoenzymes and Coenzymes. Biological Role of Metalloenzymes wrt Myoglobins, Haemoglobin. Biological Role of Carboxypeptidases, Catalases and Peroxidases.		15
UNIT II Chromatography and centrifugation	**Chromatography-** Principle, working and applications of: Affinity chromatography, Ion-exchange chromatography, Molecular (size) exclusion chromatography. **Centrifugation-** Basic Principle of sedimentation, Types of Centrifugal Separation- Differential Centrifugation, Density Gradient Centrifugation, Rotor Categories, Applications of Centrifugation		15
UNIT III Electrophoretic Techniques	**Electrophoresis:** Migration of Ions in an applied electric field; Factors affecting Electrophoretic Mobility; Moving Boundary Electrophoresis; Principle of Electrophoresis; Supporting Matrix; Paper Electrophoresis; AGE; Native and SDS PAGE (reducing and non-reducing, continuous and discontinuous); IEF and 2D PAGE. Staining and Detection Methods; Gel-Documentation. Applications in Biology.		15

Course Code	Title	Credits	No. of Lectures
USBT304	FUNDAMENTALS IN BIOPHYSICS	2	

Course objectives:-
The objective of this course is to have a firm foundation in the fundamentals and applications of current biophysical theories.
Learning outcomes:- By the end of the course the student will:

- **develop an understanding of the different aspects of classical physics.**
- **be able to relate principles of physics to applications and techniques in the field of biology such as microscopy, spectroscopy and electrophoresis**

UNIT I **Optics and Microscopy**	**Introduction to Optics and Lasers:** **Optics :** Properties of Light - Reflection, Refraction, Dispersion, Interference. **Lasers :** Properties of Lasers, Stimulated Emissions, Laser Action; Applications of Laser. **Microscopy:** Types of Microscopy; Electron Optics; Electron Microscopy- Preparation of Specimen, Construction, Principles and Working: SEM, TEM and Immuno-Electron Microscopy. Fluorescence Microscopy.		15

UNIT II **Heat, Sound, Magnetism and Fluid Dynamics**	**Heat:** Concept of Temperature; Modes of Heat Transfer; Measuring Temperature; Platinum Resistance Thermometer; Thermocouple and Thermistors. **Sound:** Types of Sound Waves - Audible, Ultrasonic and Infrasonic Waves; Doppler Effect; Applications of Ultrasonic Waves. **Magnetism:** Magnetic Field; Magnetism of Earth; Para magnetism, Diamagnetism, Ferromagnetism. Nuclear Magnetism and Biomagnetism. **Fluid Dynamics :** **Viscosity:** Definition Flow of Liquids through Capillaries; Stokes' Law; Terminal Velocity. Determination of 'η' by Falling Sphere Method; Viscosity Estimation by Oswald's Viscometer. **Surface Tension:** Definition - Surface Tension and Surface Energy; Capillary Action; Angle of Contact; Wettability; Temperature Dependence of Surface Tension. Applications in Biology.		15
UNIT III **Spectroscopy**	**Spectroscopy** Types and Properties of Spectra; Basic Laws of Light Absorption. Principle, instrumentation, working and applications of: UV Spectroscopy Fluorescence Spectroscopy Luminometry Light scattering spectroscopy Infrared Spectroscopy		15

Course Code	Title	Credits	No. of Lectures
USBT305	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:

- **understand the role of different types of cells, effector molecules and effector mechanisms in immunology.**
- **understand the principles underlying various immunotechniques.**

UNIT I Cell and organs of immune system, Complement system	**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 MHC and Antigen presentation pathways, TCR/BCR, T cell and B cell Activation	**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 Immunotechniques	**Precipitation Reactions :** Immunoprecipitation, Immunoelectrophoresis, CIEP, Rocket Electrophoresis and 2-D Immunoelectrophoresis. **Agglutination Reactions :** Passive, Reverse Passive, Agglutination Inhibition. Coomb's Test; Complement Fixation Tests, RIA, ELISA, ELISPOT, Chemiluminescence, Western Blot, Immunofluorescence, Flow Cytometry. Alternatives to Antigen-Antibody Reactions		15

Course Code	Title	Credits	No. of Lectures
USBT306	MOLECULAR BIOLOGY-III	2	

Course objectives:-
The objective of this course is to have an insight into the mechanism of gene expression and regulation.
Learning outcomes:-
By the end of the course the student will be able to:

- **discuss the mechanisms associated with gene expression at the level of transcription and translation.**
- **discuss the mechanisms associated with regulation of gene expression in prokaryotes**

UNIT I Transcription	**Transcription Process in Prokaryotes :** RNA Synthesis; Promoters and Enhancers; Initiation of Transcription at Promoters; Elongation and Termination of an RNA Chain. **Transcription in Eukaryotes :** Eukaryotic RNA Polymerases; Eukaryotic Promoters; Transcription of Protein Coding Genes by RNA Polymerase; Eukaryotic mRNA's; Transcription of other genes; Spliceosomes; RNA editing.		15
UNIT II Translation	**Nature of Genetic Code.** **Wobble Hypothesis.** **Translation in Prokaryotes and Eukaryotes:** Process of Protein Synthesis (Initiation, Elongation, Translocation, Termination); **Post Translational Modifications.** **Protein sorting.**		15
UNIT III Regulation of gene expression in Prokaryotes and Viruses	**In Prokaryotes:** lac Operon of *E.coli*; trp Operon of *E.coli*, Arabinose operon. **In Viruses :** Lytic and Lysogenic Regulation		15

Course Code	Title	Credits	No. of Lectures
USBT307	**BIOSAFETY**	2	

Objective: Learner should

- **Understand the concept of GLPs.**
- **Learn about routes of microbial contaminants and assays to detect contamination.**

Learning Outcome: Learner will be able

- **to document laboratory work, calibration records and prepare SOPs.**
- **to identify the role of the Biosafety Professional in Biomedical Research Laboratories**

UNIT I Introduction to biosafety, GLP	Introduction: Biological Risk Assessment, Hazardous Characteristics of an Agent; Genetically modified agent hazards; Cell cultures; Hazardous Characteristics of Laboratory Procedures; Potential Hazards Associated with Work Practice. Concept of GLP; Practicing GLP; Guidelines to GLP; Documentation of Laboratory work; Preparation of SOPs; Calibration records; Validation of methods; Documentation of results; Audits & Audit reports.		15
UNIT II Biosafety in diagnostics labs	Biosafety Good diagnostic lab practice and procedures Personnel competence and training Facility design Specimen and material receipt and storage Decontamination and waste management Personal protective equipment Laboratory equipment Safe techniques Emergency/incident response Occupational health Transport Maintenance of records Reporting of accidents Training		15
UNIT III Detection and testing of contaminants	Microbial Contamination in food and pharma products; Some common microbial contaminants; Microbiological Assays for pharmaceutical products; Regulatory Microbiological testing in pharmaceuticals.		15

SEMESTER IV

Course Code	Title	Credits	No. of Lectures
USBT401	**MEDICAL BIOTECHNOLOGY**	**2**	

Course objectives:- Learner should

- **Comprehend pathogenesis and diagnosis process**
- **Understand mechanism of drug action and mode of drug resistance.**

Learning outcomes:- Learner will be able to

- **Demonstrate knowledge for infectious agents and drug action mechanisms**
- **to identify drug resistance problems in disease treatment.**

UNIT I **Viral and fungal diseases**	Pathogenesis, clinical symptoms, laboratory diagnosis, epidemiology, prophylaxis and treatment of Viral diseases Air borne viral diseases: Influenza ,measles, COVID Vector Borne viral diseases: (Dengue, AIDS, Rabies). Fungal diseases- transmission, symptoms and prevention of cutaneous mycoses (Athlete's foot), systemic mycoses (Histoplasmosis) and opportunistic mycoses (Candidiasis)		15
UNIT II **Chemotherapeutic agents I**	Discovery and Design of antimicrobial agents; Classification of Antibacterial agents, Selective toxicity, MIC, MLC Inhibition of cell wall synthesis (Mode of action for): Beta lactam antibiotics: Penicillin, Cephalosporins; Glycopeptides: Vancomycin; Polypeptides: Bacitracin Injury to Plasma membrane: Polymyxin; Inhibition of protein synthesis Aminoglycosides, Tetracyclines Chloramphenicol, Macrolides Erythromycin; Inhibition of Nucleic acid synthesis: Quinolones, Rifampicin, Metronidazole ; Antimetabolites: Sulphonamides, Trimethoprim;		15

UNIT III **Chemotherapeutic agents II**	Antimicrobial susceptibility tests Drug Resistance: Mechanism, Origin and transmission of drug resistance; Use and misuse of antimicrobial agents; **Antifungal drugs**, Azoles,Polyenes, Echinocandins, Sllylamines, Pyrimidine Analogues **Antiviral drugs :** Drugs that target the viral DNA polymerase (Acyclovir,Gancyclovir) Nucleoside and nucleotide reverse transcriptase inhibitors (Zidovudine) Non-nucleoside reverse transcriptase inhibitors (Nevirapine) Protease inhibitors Fusion inhibitors(Enfuvirtide)		15

Course Code	Title	Credits	No. of Lectures
USBT402	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**	**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.		15
UNIT II **Cell membrane**	**Cell Membrane :** Uptake of Nutrients by Prokaryotic Cells; Cell Permeability. Principles of Membrane Transport Transporters and Channels; Active Transport, Passive Transport; Types of Transporters; Types of ATP Driven Pumps - Na+ K+ Pump. Cell Junctions; Cell Adhesion and Extracellular Material Microvilli; Tight Junctions, Gap Junctions; Cell Coat and Cell Recognition. Cellular Interactions.		15

UNIT III **Cytogenetics**	**Cytogenetics :** Structure of Chromosome - Heterochromatin, Euchromatin, Polytene Chromosomes. 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. Sex Determination and Sex Linkage : Mechanisms of Sex Determination (XX-XY, ZZ-ZW, XX-XO) Dosage Compensation and Barr Body. Genetic Linkage, Crossing Over and Chromosomal Mapping : Tetrad Analysis; Two-point Cross; Three point Cross; Pedigree Analysis.		15

Course Code	Title	Credits	No. of lectures
USBT403	APPLIED CHEMISTRY-2	2	

Course objectives:-

The objective of this course is to have a firm foundation in 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 **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 II **Natural product chemistry and green chemistry**	**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. **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

UNIT III **Nanotechnology**	**Nanomaterials :** Introduction to Nanomaterials. Forms of Nanomaterials : Nanoparticles, Nanofilms and Nanotubes Synthesis and Characterization of Nanomaterials. Applications of Nanomaterials.		

Course Code	Title	Credits	No. of lectures
USBT404	**BIOCHEMISTRY**	**2**	

Course objectives:-

- **Understand the order of reactions involved in carbohydrate, amino acid and lipids metabolism.**
- **Learn how the metabolism pathways are regulated at molecular level.**

Learning outcomes:- Learner should:

- **Be able to illustrate the metabolism of carbohydrates, amino acids and lipids through various metabolic pathways.**
- **Be able to undertake investigations and perform analysis that provide information about metabolic disorder.**

UNIT I **Carbohydrate Metabolism, ETS and Energy Rich Compounds**	**Carbohydrate Metabolism :** Glycolytic Pathway and its Regulation, Homolactic Fermentation; Alcoholic Fermentation; Energetics of Fermentation; Citric Acid Cycle and its Regulation; Gluconeogenesis; Pentose Phosphate Pathway; Glyoxalate Pathway; Reductive TCA . (Sequence of Reactions, Regulation, Energy Yield and Metabolic Disorders of the above Pathways) **Electron Transport System :** Electron Transport and Oxidative Phosphorylation. Inhibitors of ETS. **Energy Rich Compounds :** ATP as Energy Currency, Structure of ATP, Hydrolysis, Other Energy Rich Compounds other than ATP like PEP, Creatine Phosphate, etc.		**15**

UNIT II **Amino acid metabolism**	**Amino Acid Breakdown :** Deamination, Transamination, Urea Cycle, Breakdown of Glucogenic and Ketogenic Amino Acids. Amino Acids as Biosynthetic Precursors : Biosynthesis of Epinephrine, Dopamine, Serotonin, GABA, Histamine, Glutathione. (Sequence of Reactions, Regulation and Metabolic Disorders of the above Pathways)		**15**
UNIT III **Lipid metabolism**	**Lipid Metabolism :** Mobilization, Transport of Fatty Acids. Beta, Alpha and Omega Oxidation of Saturated Fatty Acids; Oxidation of Unsaturated Fatty Acids; Oxidation of Odd Chain Fatty Acids. Energy Yield, Ketone Body Breakdown to Yield Energy. (Sequence of Reactions, Regulation, Energy Yield and Metabolic Disorders of the above Pathways)		**15**

Course Code	Title	Credits	No. of Lectures
USBT405	MOLECULAR DIAGNOSTICS	2	

Course objectives:-

The objective of this course is learning and understanding molecular techniques and utilizing these techniques in diagnosis.

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

- **gain an understanding of the basic principles used in molecular diagnosis.**
- **gain critical thinking and analytical skills to understand new diagnostic methods.**
- **apply the knowledge and skills gained in the course should be useful in developing new diagnostic kits.**

UNIT I Basics of molecular diagnostics	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. Characterisation and analysis of Nucleic – Acids and Proteins : Extraction, Isolation and Detection of DNA, RNA and Proteins; Restriction Endonucleases and Restriction Enzyme Mapping. Hybridisation Techniques : Southern, Northern, Western and FISH; Markers, Probes and its Clinical Applications.		15
UNIT II Nucleic acid amplification methods	**Target amplification :** PCR - General Principle; Components of a Typical PCR Reaction; Experimental Design; Primer Designing; Control of PCR Contamination and Mispriming; PCR Product Clean-up and Detection. **PCR Types :** Reverse Transcriptase and Real Time PCR. **Probe amplification :** Ligase Chain Reaction		15

UNIT III Molecular biology based diagnostics	DNA Polymorphism and Identification: RFLP and Parentage Testing; RFLP and Sickle-Cell Anaemia. Genetic Counseling and Molecular Diagnosis Genetic Testing- Need and Uses; genetic Counseling. 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
USBT406	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	**Computer Basics :** Basic Computer Operations: I/O Units; Computer Memory; Processor; Binary Arithmetic; Logic Circuit; Architecture; Operating Systems and application softwares. **Biological Databases :** **Classification of Databases -** Raw and Processed Databases; Primary (NCBI), Secondary (PIR) and Tertiary or Composite (KEGG) Databases; Structure and Sequence Databases. **Specialized Databases -** Protein Pattern Databases; Protein Structure and Classification Databases (CATH/SCOP). Genome Information Resources: DNA Sequence Databases Specialized Genomic Resources. Protein Databases based on Composition, Motifs and Patterns. Protein Structure Visualization Software.		15
UNIT II BLAST and sequence alignment	**BLAST and Sequence Alignment :** BLAST and its Types; Retrieving Sequence using BLAST. **Pairwise Alignment :** Identity and Similarity; Global and Local Alignment; Pairwise Database Searching. Multiple Sequence Alignment: Goal of Multiple Sequence Alignment; Computational Complexity; Manual Methods; Simultaneous Methods; Progressive Methods; Databases of Multiple Alignment; Secondary Database Searching; Analysis Packages; MSA.		15

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 Man, Paired and Unpaired; Chi Square Test.		

Course Code	Title	Credits	No. of Lectures
USBT407	RESEARCH METHODOLOGY	2	

Course objectives:-
The objective of this course is to develop research aptitude, logical thinking and reasoning.
Learning outcomes:- By the end of the course the student will be able to:

- **understand basic principles of research methodology and identify a research problem.**
- **understand a general definition of research design.**
- **identify the overall process of designing a research study from its inception to its report.**

UNIT I Introduction to Research Methodology and Research Problem	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		15
UNIT II Research Design, Data Collection and processing	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 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		15
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

PRACTICALS

	SEMESTER III	
Course code	**Title**	**Credits**
USBTP301 (PRACTICALS based on USBT301 and USBT302)	1. Study of composition and use of important differential media for identification of bacteria: EMB Agar, McConkey agar, Mannitol salt agar, Deoxycholate citrate agar, TCBS 2. Isolation of *S.aureus using* selective and differential media 3. Identification of *S.aureus*- Catalase, Coagulase Test. 4. Isolation of *E.coli* using selective and differential media 5. Identification of *E.coli*- Sugar Fermentations, IMViC. 6. Isolation of *Salmonella using selective and* differential media 7. Identification of *Salmonella*- Sugar Fermentations, TSI Slant. 8. Isolation of *Shigella using selective and* differential media 9. Identification of *Shigella*-, Sugar Fermentations, TSI Slant. 10. Isolation of *Pseudomonas using selective and* differential media 11. Identification of *Pseudomonas* - Urease test, Oxidase Test, TSI Slant. 12. Lab Scale Production of Penicillin (Static and Shaker). 13. Purification of *Penicillin* from Broth Culture of *Penicillium spp.* by Solvent Extraction. 14. Estimation of *Penicillin* from Recovered Broth by Chemical (Iodometric) Method. 15. Estimation of *Penicillin* from Recovered Broth by Biological (Bioassay) Method. 16. RPR Test (Kit Based). 17. Permanent Slide- Mycobacterium.	2
Course code	**Title**	**Credits**
USBTP302 (PRACTICALS based on USBT303 and USBT304)	1. SOP writing for Spectrophotometer 2. Estimation of hemoglobin by Cyanmethemoglobin Method. (Drabkin's reagent based kit can be used)- **DEMONSTRATION ONLY** 3. Qualitative analysis of DNA using Agarose Gel Electrophoresis. 4. Determination of Purity of DNA using UV Spectrophotometry. 5. Electrophoresis of Proteins by Native PAGE.	2

	6. Electrophoresis of Proteins by SDS PAGE. 7. Separation of components from a mixture using Size exclusion chromatography (Kit may be used for demonstration) 8. Separation of components from a mixture using ion exchange chromatography (Kit may be used for demonstration) 9. Separation of components from a mixture using Affinity chromatography (Kit may be used for demonstration) 10. Study of the Structure and Function of an Electron Microscope (Visit / Video Demonstration). 11. Demonstration of sample preparation and staining for analysis using Electron Microscope. 12. Study of the Structure and Working of a Fluorescence Microscope 13. Demonstration of sample preparation and staining of sample for analysis using Fluorescence Microscope. 14. Quantitative test- Catalase activity 15. Quantitative test- Peroxidase activity 16. Quantitative analysis of amylase extracted from a plant or bacterial source.	

Course code	Title	Credits
USBTP303 (PRACTICALS based on USBT305 and USBT306)	1. Complement Fixation Test (CFT). 2. Passive Agglutination- RA Factor Test. 3. Immunoelectrophoresis. 4. Immunodiffusion technique - Single Radial Immunodiffusion by Mancini Method 5. Immunodiffusion- double immunodiffusion by Ouchterlony Method 6. ELISA (Kit-based) - HEPELISA. 7. DOT-ELISA. 8. Western Blotting - Demonstration. 9. Flow Cytometry - Lab Visit. 10. Qualitative detection of *Salmonella spp*- Rapid Slide agglutination test 11. Quantitative detection of *Salmonella spp*- Tube Agglutination test 12. Coomb's test (Demonstration) 13. Study of *E.coli* Diauxic Growth Curve- (Lactose and Glucose). 14. Study of *lac* Gene Expression using Blue-White Selection. 15. Chloroplast isolation using density gradient centrifugation. 16. Expression of β-galactosidase and Measurement of Activity.	**2**

	SEMESTER IV	
Course code	**Title**	**Credits**
USBTP401 (PRACTICALS based on USBT401 and USBT402)	1. Screening for an Antibiotic Producing Strain of Microorganism by Crowded plate Technique. 2. Screening for an Antibiotic Producing Strain of Microorganism by Wilkin Overlay plate Technique 3. MIC of any one antibiotic 4. MLC of any one antibiotic 5. Antibiotic sensitivity test using agar cup method 6. Antibiotic sensitivity test using paper disc method 7. Antibiotic sensitivity test using ditch method. 8. To study synergistic action of drugs 9. Study of Chromosomal Aberrations- Deletion, Duplication, Inversion, Translocation and Syndromes- Trisomy 21 Trisomy 13 Trisomy 18, Klinefelter, Turner and Cri-du-Chat. 10. Induction of Polyploidy by PDB Treatment using Suitable Plant Material. 11. Study of Polytene Chromosomes. 12. Mapping based on Tetrad Analysis and Three Point Cross. 13. Pedigree Analysis- Autosomal and Sex-Linked. 14. Material/Microscopic observation/display of photographs of human pathogens as per theory syllabus Paramyxovirus virus, Rhabdovirus, HIV. 15. Material/Microscopic observation/display of photographs of human pathogens as per theory syllabus- fungi-Candida albicans, Tinea, Trichomonas vaginalis.	2
USBTP402 (PRACTICALS based on USBT403 and USBT404)	1. Purification of any TWO Organic Compounds by Recrystallization Selecting Suitable Solvent. 2. Estimation of Acetone 3. Estimation of Amide 4. Estimation of Benzoic Acid. 5. Organic Preparations (Any ONE salt) : a) Acetylation of Primary Amine (Preparation of Acetanilide). b) Base Catalysed Aldol Condensation (Synthesis of Dibenzalpropanone). 6. Separation of Binary (Solid-Solid) Mixture (Min TWO). 7. Identification of Organic Compounds of Known Chemical Type (Min TWO). a. Preliminary examination b. Solubility profile c. Detection of elements C, H, (O), N, S and X. d. Detection of functional groups	2

	e. Determination of physical constants (M.P/B.P) f. Confirmatory tests to be performed. 8. Determination of Lactate Dehydrogenase (LDH) Activity in Blood Serum. 9. Determination of Total, LDL and HDL Cholesterol in Serum. 10. Organ Function Tests: Liver (SGPT, SGOT); Kidney (Urea from serum). 11. Estimation of Uric Acid and Creatinine in Urine. 12. Qualitative Detection of Ketone Body in Urine. 13. HPLC analysis and Interpretation of any one Secondary Metabolite from Plants 14. HPTLC fingerprint analysis of any one Medicinally Important Plant. 15. Chemical and Biological Synthesis of Silver Nanoparticles and its Characterisation by UV- VIS Spectrophotometer.	

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. 4. Classification of Proteins using CATH and SCOP. 5. Visualization PDB Molecules using PyMOL and Swiss-PDB Viewer. 6. Isolation and Detection of RNA from Bacteria OR Yeast. 7. Restriction site analysis of lambda phage DNA. 8. Primer Designing through Open Online Source NCBI- BLAST. 9. DNA Amplification – PCR. 10. Genetic Counseling and Molecular Diagnosis Genetic Testing 11. Case Studies- for Cystic Fibrosis; Fragile X Diagnostic and Carrier. 12. Problems based on correlation, 13. Problems based on t test, 14. Problems based on z-test 15. Problems based on Chi Square Test 16. Problems based on Regression	2

Teaching pattern:

One (01) Credit would be of thirty to forty (30-40) learning hours; of this, more than fifty per cent of the time will be spent on classroom instructions including practical asprescribed 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 (45 Lectures as classroom 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 purposes only. Students and faculty are encouraged to explore additional reference books, online lectures, videos, science journals for latest/ additional information.

EVALUATION SCHEME

The performance of the learners shall be evaluated into TWO Parts.

1. Internal Assessment with 25 marks
2. Semester End Examinations with 75 marks.

Practical Training will have Practical Examination for 100 marks per practical paper at the end of Semester. The allocation of marks for the Internal Assessment and Semester End Examinations are as follows: -

For Core subjects:

A. Internal Exam-25 Marks

i. Test/Assignment/Project/Presentation– 20 Marks

ii. Activities and Attendance - 5 Marks

B. Semester End Examination - 75 Marks

C. Practical Examination – Each practical paper **Sem -3 (USBTP301, USBTP302, USBTP303) and Sem- 4 (USBTP401, USBTP402, USBTP403)** of 100 marks = 3 core practical papers

For Ability Enhancement Course:

A. Internal Exam-25 Marks

i. Assignment/Project/Presentation – 20 Marks

ii. Activities and Attendance - 5 Marks

B. Semester End Examination- 75 Marks

REFERENCES

SEMESTER III

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2. Introduction to Instrumentation in Life Sciences, Prakash S. Bisen Anjana Sharma. International Standard Book Number-13: 978-1-4665-1241-2
3. Industrial Microbiology- A. H. Patel
4. Industrial Microbiology- L. E. Casida- John Wiley & Sons
5. Microbiology–6th Edition (2006), Pelczar M.J., Chan E.C.S., Krieg N.R., The McGraw Hill Companies Inc. NY
6. Presscott's Microbiology, 8th edition (2010), Joanne M Willey, Joanne Willey, Linda
7. Sherwood, Linda M Sherwood, Christopher J Woolverton, Chris Woolverton, McGraw Hill Science Engineering, USA
8. Textbook of Medical Microbiology- Anantnarayan
9. Microbiology- Frobisher
10. General Principles of Microbiology- Stanier
11. Fermentation technology by Stanbury and Whittkar
12. Basic principles of medical microbiology and immunology. Kayser, F. H., Bienz, K. A., Ckert, J. E., & Zinkeernagel, R. M. (2005).Kayser, F. H., Bienz, K. A., Ckert, J. E., & Zinkeernagel, R. M. (2005).
13. Biosafety in Microbiological and Biomedical Laboratories-CDC
14. LABORATORY BIOSAFETY MANUAL FOURTH EDITION-WHO
15. Laboratory Quality Management System handbook- WHO
16. College Organic Chemistry T.Y. B.Sc., ISBN Number : 978-93-5299-235-5
17. Organic Chemistry, R.T. Morrison, R.N. Boyd and S.K. Bhatacharjee, 7th Edition, Pearson Education (2011).
18. Organic Chemistry, T.W.G. Solomon and C.B. Fryhle, 9th Edition, John Wiley & Sons, (2008)
19. A guide to mechanism in Organic Chemistry, 6th Edition, Peter Sykes, Pearson Education
20. Fundamentals of Organic Chemistry , G. Marc Loudon, 4th Edition Oxford Organic Chemistry, L.G. Wade Jr and M.S. Singh, 6th Edition,2008
21. Organic Chemistry, Paula Y. Bruice, Pearson Education, 2008
22. Organic Chemistry, J.G. Smith, 2nd Edition Special Indian Edition, Tata 21 McGraw Hill
23. Organic Chemistry, S.H. Pine, McGraw Hill Kogakusha Ltd
24. NCERT XIth, XIIth Physics Textbook.
25. Kuby immunology, Judy Owen , Jenni Punt , Sharon Stranford., 7th edition (2012), Freeman and Co., NY
26. Textbook of basic and clinical immunology, 1st edition (2013), Sudha Gangal and Shubhangi Sontakke, University Press, India
27. Immunology, 7th edition (2006), David Male, Jonathan Brostoff, David Roth, Ivan Roitt, Mosby, USA.
28. Genes XI, 11th edition (2012), Benjamin Lewin, Publisher - Jones and Barlett Inc. USA
29. iGenetics- Peter Russell -Pearson Education
30. Biophysical Chemistry by James P Allen.

SEMESTER IV

1. Methods in Biostatistics- B. K. Mahajan –Jaypee Brothers
2. Lehninger , Principles of Biochemistry. 5th Edition (2008), David Nelson & Michael Cox, W.H. Freeman and company, NY.
3. Introductory Biostatistics. 1st edition. (2003), Chap T. Le. John Wiley, USA
4. Methods in Biostatistics- B. K. Mahajan –Jaypee Brothers
5. Introductory Biostatistics. 1st edition. (2003), Chap T. Le. John Wiley, USA
6. Outlines of Biochemistry: 5th Edition, (2009), Erice Conn & Paul Stumpf ; John Wiley and Sons, USA
7. Principles of Biochemistry, 4th edition (1997), Jeffory Zubey, McGraw-Hill College, USA
8. Fundamentals of Biochemistry. 3rd Edition (2008), Donald Voet & Judith Voet , John Wiley and Sons, I. USA
9. Biochemistry: 7th Edition, (2012), Jeremy Berg, Lubert Stryer, W.H.Freeman and company, NY
10. An Introduction to Practical Biochemistry.3rd Edition, (2001), David Plummer, Tata McGraw Hill Edu. Pvt.Ltd. New Delhi, India
11. Biochemical Methods.1st , (1995), S. Sadashivam, A.Manickam, New Age International Publishers, India
12. Textbook of Biochemistry with Clinical Correlations, 7th Edition, Thomas M. Devlin, January 2010,
13. Proteins: biotechnology and biochemistry, 1st edition (2001), Gary Walsch, Wiley, USA
14. Biochemical Calculations, 2nd Ed., (1997) Segel Irvin H., Publisher: John Wiley and Sons, New York.
15. Mim's Medical Microbiology 5th edition
16. College Organic Chemistry T.Y. B.Sc., ISBN Number : 978-93-5299-235-5
17. Organic Chemistry, R.T. Morrison, R.N. Boyd and S.K. Bhatacharjee, 7th Edition, Pearson Education (2011).
18. Organic Chemistry, T.W.G. Solomon and C.B. Fryhle, 9th Edition, John Wiley & Sons, (2008)
19. A guide to mechanism in Organic Chemistry, 6th Edition, Peter Sykes, Pearson Education
20. Fundamentals of Organic Chemistry , G. Marc Loudon, 4th Edition Oxford
    Organic Chemistry, L.G. Wade Jr and M.S. Singh, 6th Edition,2008
21. Organic Chemistry, Paula Y. Bruice, Pearson Education, 2008
22. Organic Chemistry, J.G. Smith, 2nd Edition Special Indian Edition, Tata 21 McGraw Hill
23. Organic Chemistry, S.H. Pine, McGraw Hill Kogakusha Ltd
24. Research methodology- C.R. Kothari
25. Bioinformatics: Methods and Applications: Genomics, Proteomics and Drug Discovery, N. Mendiritta, P. Rastogi, S. C. Rastogi
26. Cell and Molecular Biology – De Robertis- Lippincott Williams& Wilkins
27. Karp's Cell and Molecular Biology: Concepts and Experiments—Karp – Wiley International
28. Molecular Diagnostics: Fundamentals, Methods, and Clinical Applications Third Edition, Lela Buckingham.
29. Cytogenetics, P. K. Gupta.
30. https://spdbv.unil.ch/
31. https://pymol.org/2/
32. https://www.ncbi.nlm.nih.gov/tools/primer-blast/
33. https://blast.ncbi.nlm.nih.gov/Blast.cgi
34. https://www.ebi.ac.uk/Tools/psa/emboss_needle/
35. https://www.ebi.ac.uk/Tools/msa/clustalo/

Garje

Prof. Shivram S. Garje,
Dean,
Faculty of Science and Technology

TYBSc. BT. 2016 - 2

Academic Council
Item No.

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 **2016-2017**)

T.Y.B.Sc.
BIOTECHNOLOGY
SEMESTER V AND VI
REVISED SYLLABUS (CBSGS) 2016-2017

SEMESTER V

COURSE	TITLE	UNIT	TOPICS	CREDITS	L/WEEK
USBT501	Cell Biology and Medical Biotechnology	I	Cytoskeleton	2	1
		II	Cell membrane		1
		III	Medical Biotechnology- Causative organisms		1
		IV	Virology		1
USBT502	Biochemistry, Immunology and Instrumentation	I	Immunology	2	1
		II	Endocrinology		1
		III	Carbohydrate metabolism		1
		IV	Instrumentation		1
USBT503	Genetics and Molecular Biology	I	Genetic mapping	2	1
		II	Operon concept and transposons		1
		III	Vectors and enzymes in Molecular Biology		1
		IV	Recombinant DNA libraries		1
USBT504	Industrial Biotechnology	I	Types of fermentors and process control	2	1
		II	Screening, inoculum and strain development		1
		III	Fermentations		1
		IV	Downstream processing		1
USBTP05 & 06		Practical Based on theory		2	9

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SEMESTER VI

COURSE	TITLE	UNIT	TOPICS	CREDITS	L/WEEK
USBT601	Cell Biology, Medical Biotechnology and Biostatistics	I	Cell signaling and signal transduction	2	1
		II	Cell cycle, apoptosis and cancer		1
		III	Chemotherapeutic agents		1
		IV	Biostatistics		
USBT602	Biochemistry, Immunology and Instrumentation	I	Immunotechnology	2	1
		II	Endocrinology		1
		III	Lipid Metabolism		1
		IV	Instrumentation		1
USBT603	Molecular Biology and Bioinformatics	I	rDNA technology	2	1
		II	Transgenic plants		1
		III	Transgenic animals		1
		IV	Bioinformatics		1
USBT604	Industrial Biotechnology	I	Dairy technology	2	1
		II	Environmental Biotechnology		1
		III	Biofertilizers, Biopesticides, Biosurfactants and biosensors		1
		IV	IPR ,Quality Assurance, Entrepreneurship		1
USBTP07 & 08		Practical Based on theory and Skill based project		2	9

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SEMESTER V

COURSE CODE	TITLE	CREDITS
USBT501	Cell Biology and Medical Biotechnology	2 credits
Unit I Cytoskeleton	Overview of Cytoskeleton Microtubules: Structure, Composition, MAPs, Functions- Role in mitosis, Structural support and Intracellular motility. Motor proteins, MTOCs, Dynamic properties of microtubules, Microtubules in cilia and flagella. Drugs targeting microtubules 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.	15 lectures
Unit II Cell membrane	Introduction and overview of functions: Fluid Mosaic Model, Chemical composition; Membrane Lipids- Phosphoglycerides, Sphingolipids, Cholesterol, Membrane Carbohydrates- Sugars, Oligosaccharides. Membrane Proteins- Integral, Peripheral, Lipid anchored. Membrane lipids and fluidity- Importance, Maintenance & Asymmetry. Dynamic nature- Flip flop and lateral movement. Cell permeability-Principles of membrane transport: Transporters and Channels. Active transport, Passive transport. Types of transporters, Types of ATP driven pumps - Na+ K+ pump. Cell junctions, cell adhesion and extracellular material Microvilli, Tight junctions, Gap junctions, Cell coat and cell recognition, Cellular interactions. ECM of animal connective tissue: Hyaluronic acid, GAGs, Proteoglycans.	15 lectures

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Unit III Medical Biotechnology- Causative organisms	Skin Infections- *Staphylococcus:* Characteristics Pathogenesis and immunity Toxins, Enzymes, Clinical Disease, Lab diagnosis, Treatment, Prevention and Control. *Dermatophytes:* Superficial and Cutaneous mycoses Respiratory Tract Infections- *M. tuberculosis*: Characteristics Transmission, Course of infection, Lab diagnosis, Management of TB, Prevention and Control, Immuno and Chemoprophylaxis, DOTS and MDR. Urinary Tract Infections- *E.coli* : Characteristics, Virulence, Clinical disease, Traveller's diarrhoea and *E.coli* infections. GI Tract Infections- *Salmonella:* Characteristics, Virulence- Pathogenesis &Immunity, Clinical Disease, Carriers Lab diagnosis, Phage typing Prophylaxis and Treatment Sexually Transmitted Diseases- HIV: Characteristics Pathogenesis Transmission &Population at risk, Opportunistic infections, Lab diagnosis, Treatment, Prevention and Control, Vaccine development Parasitic Blood infection- Malarial parasites: Life Cycle, Diagnosis and Treatment	15 lectures
Unit IV Virology	Introduction to viruses-Position in biological spectrum Virus properties, General structure of viruses Baltimore Classification and Taxonomy(ICTV), Cultivation of viruses, Virulent phages and Lytic cycle - T even phages, One step growth experiment Temperate phages and lysogeny - lambda phage, Reproduction of ds DNA phages, animal viruses and plant virus Virus purification and assays Cytocidal infections and cell damage Viruses and cancer Viroids and Prions	15 lectures

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COURSE CODE	TITLE	CREDITS
USBT502	**Biochemistry, Immunology and Instrumentation**	2 credits
Unit I Immunology	Structure and Function of the Immune system: Cells and organs of immune system Membrane receptors for antigens: MHC–Class I and Class II molecules. Antigen Presentation by Endocytic and Exocytic Pathway Immune response Theories, B Cell Receptor, T Cell Receptor and Accessory Molecules CD4, CD8. Complement system : Classical Pathway and Alternate Pathway.	15 lectures
Unit II Endocrinology	Mechanism of action of group II hormones Storage, Release, transport, functions and disorders of – Hypothalamic hormones Anterior Pituitary hormones – GH & stimulating hormones (hCG, LH, FSH, TSH) Posterior pituitary hormones – ADH and oxytocin Adrenal medulla hormones – epihephrine and nor-epinephrine Pancreatic hormones – Insulin and Glucagon	15 lectures
Unit III Carbohydrate metabolism	Biochemical pathway for Synthesis and regulation of carbohydrates in Bacteria –Peptidoglycan Plants - Calvin cycle, C4, CAM, starch and sucrose Animals – Glycogen synthesis and breakdown Gluconeogenesis	15 lectures
Unit IV Instrumentation	Chromatography: Principle , working and application of Affinity, Ion-exchange, Gel permeation, HPLC and GC. Centrifugation: Types, principle, working and applications of Differential and Density Gradient - Isopycnic, Rate zonal, Gradient materials, preparation, sample application, recovery, choice of rotors.	15 lectures

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COURSE CODE	TITLE	CREDITS
USBT503	**Genetics and Molecular Biology**	**2**
Unit I Genetic mapping	Genetic mapping in bacteria and Bacteriophages: Gene mapping in bacteria by conjugation, transformation and transduction. Mapping bacteriophage genes, Fine structure analysis of bacteriophage gene, Deletion mapping, and Defining genes by complementation tests.	15 lectures
Unit II Operon concept and transposons	Regulation of gene expression in bacteria and bacteriophages: Operon concept. *lac* and *trp* operons- Gene organization and regulation. Regulation of gene expression in phage λ. Transposons in prokaryotes and eukaryotes- IS elements, composite and non-composite transposons, plant transposons Transposable phage (phage Mu)	15 lectures
Unit III Vectors and enzymes in Molecular Biology	Enzymes - Sources, types, mode of action and applications of Restriction endonucleases, DNA polymerases, Ligases, Kinases, Phosphatases, Terminal transferases, Reverse transcriptases and Nucleases, Sequenase and Taq polymerase Vectors - Features and applications of pBR322, pUC19, cosmids, λ phage, M13 bacteriophage vector, Shuttle vector, Expression vector, Ti plasmid, Artificial chromosomes- YAC, BAC	15 lectures
Unit IV Recombinant DNA libraries	Construction and screening of Genomic libraries, cDNA libraries, Chromosome libraries. Probes-synthesis (Random priming, Nick translation) Use of probes to identify genes and cDNA in libraries. Molecular analysis of cloned DNA- restriction mapping	15 lectures

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COURSE CODE	TITLE	CREDITS
USBT504	**Industrial Biotechnology**	**2**
Unit I Types of fermentors and Process control	Fermentors – Acetator & Cavitator, Tower fermentor, Airlift fermentor, Bubble column fermentor, Deep jet fermentor, Packed Bed, Bioreactors for animal cell culture, Stirred tank fermentor, Packed glass bead reactor. Process Control-Temperature control, flow measurement, pressure, biomass, DO, pH, redox, inlet and exit gas analysis. Addition of inoculum and nutrients. Sampling port, feed port, sensor probes, foam control.	15 lectures
Unit II Screening, inoculum and strain development.	Primary screening, secondary screening, inoculum and strain development Scale up, scale down	15 lectures
Unit III Industrial Fermentations	Wine and beer: Introduction, manufacturing/processing, spoilage Malo-lactic fermentation Production of : Penicillin, Streptomycin, Vinegar, Citric acid Single cell protein (Mushroom)	15 lectures
Unit IV Downstream processing	Introduction of DSP Foam separation, Types of Precipitation, Filtration, Centrifugation, Chromatography in DSP Cell disruption- physical and chemical methods. Solvent recovery, Membrane processes, Drying, Crystallization and Whole broth processing.	15 lectures

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PRACTICALS		
COURSE CODE	**TITLE**	**CREDITS**
USBTP05	Determination of Total RBC count Determination of Total WBC count Differential staining of Blood Film Medical Biotechnology: ✓ Identification of *S.aureus*-Isolation, Catalase, Coagulase test ✓ Identification of *E.coli*-Isolation, Sugar fermentations, IMViC ✓ Identification of *Salmonella*- Isolation, Sugar fermentations, TSI slant MIC and MLC of antibiotic Preparation of Solutions Glucose estimation from serum using GOD-POD method Estimation of starch (Willstater's method)	**1**
USBTP06	Isolation of plasmid bearing culture and extraction of plasmid DNA and demonstration of its presence by agarose gel electrophoresis Transformation and Screening for transformants by replica plate method Construction of restriction map Problems on mapping of bacterial genes Bioassay of penicillin Isolation of antibiotic producing organism- crowded plate technique & Wilkins agar overlay technique Encapsulation of yeast and estimation of invertase activity Vinegar analysis	**1**

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SEMESTER VI

COURSE CODE	TITLE	CREDITS
USBT601	Cell biology and Medical Biotechnology	2 credits
Unit I Cell signalling & Signal Transduction	General Principles of cell communication: Introduction, Extracellular signal molecules binding to receptors, Forms of intercellular signalling - Autocrine, Contact dependent, Paracrine, Synaptic and Endocrine. Role of gap junction in signalling Response to multiple extracellular signal molecules Morphogens, Lifetime of intracellular molecule, Role of Nitric oxide and nuclear receptors Binding reaction and role of Kd, Extracellular messengers and their receptors, GPCRs RTKs, Second messengers Role of Calcium- Introduction, Calcium binding proteins	15 lectures
Unit II Cell cycle, apoptosis and cancer	Cell cycle- Overview of cell cycle and Phases, Check points Apoptosis and Necrosis: Definition and Process Apoptosis: Caspases and targets, Factors which regulate apoptotic death in normal cells. Significance and role of apoptosis in various diseases. Cancer: Definition, Characteristics of normal cell and cancerous cell. Tumor- Benign and malignant, types of cancer, oncogenes and tumor suppressor genes, invasion metastasis, angiogenesis, preventive measures for cancer Cancer vaccines	15 lectures
Unit III Chemotherapeutic agents	Discovery and Design of antimicrobial agents: Classification of Antibacterial agents Selective toxicity, MIC,MLC, Inhibition of cell wall synthesis: Beta lactam antibiotics, Penicillins Cephalosporins, Glycopeptides Vancomycin, Polypeptides Bacitracin,	15 lectures

	Injury to Plasma membrane: Polymyxin Inhibition of protein synthesis: Aminoglycosides, Tetracyclines Chloramphenicol, Macrolides-Erythromycin Inhibition of Nucleic acid synthesis: Quinolones Rifampin Metronidazole, Antimetabolites Sulphonamides, Trimethoprim Drug Resistance: Mechanism, Origin and transmission of drug resistance Use and misuse of antimicrobial agents, Antifungal drugs, Antiviral drugs	
Unit IV Biostatistics	Concept of Biostatistics- Definition of biostatistics, terms used and Scope in Biological sciences, Types of Data and Representation of data using frequency distribution diagram (Simple/Multiple/Subdivided bar diagram, Pie chart), Graphs (Histogram, polygon, curve) Normal probability curve Measures of central tendency: Mean – Arithmetic mean, assumed mean. Median- raw data and grouped data. Mode: - raw data and grouped data. Measures of dispersion: Concept of Variance, Standard deviation and Coefficient of variance 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 Nonparametric test:- Chi-square test.	15 lectures

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COURSE CODE	TITLE	CREDITS
USBT602	**Biochemistry, Immunology and Instrumentation**	**2 credits**
Unit I Immunotechnology	Antigen-antibody reaction General Features of Antigen antibody reactions Measurements of Antigen-antibody reactions Types of Serological Reactions: Precipitation, Agglutination, Flocculation. Types and Application of Immunoassay techniques: RIA, ELISA, Elispot, Immuno precipitation, Immunoflourescence. FACS ImmunoBlotting Diagnostic Tests: Coomb's test and Complement Fixation Test	15 lectures
Unit II Endocrinology	Definition and Classification of hormones based on chemical nature and mode of action Mechanism of action of group I hormones: Storage, release, transport, functions and disorders of – Thyroid hormones – T3 and T4 Adrenal cortex hormones – Glucocorticoids and mineralocorticoids Calcitriol Hormones of Gonads – Androgen, estrogen, progesterone.	15 lectures
Unit III Lipid metabolism	Biochemical pathway for Synthesis and regulation of- Fatty acids (even and unsaturated), Triacylglycerol, Phospholipids (Phosphatidyl choline, Phosphatidyl ethanolamine and Phosphatidyl serine), Cholesterol and Ketone bodies	15 lectures
Unit IV Instrumentation	Isotopes in Biology: Detection Techniques of Radioactivity using GM counter, Scintillation counter, Applications of Tracer techniques in Biology Microscopy: Principle, working and applications of TEM,SEM & confocal Spectroscopy- Principle, working and applications of IR and Spectrofluorimetry	15 lectures

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COURSE CODE	TITLE	CREDITS
USBT603	**Molecular Biology and Bioinformatics**	**2**
Unit I rDNA technology	Principle, method and applications of Southern Hybridization, DNA fingerprinting, RFLP, DNA sequencing(Sangers, Automated) PCR(qPCR /Real time PCR, RT PCR) Vaccines: Sub unit vaccines(HSV), Peptide vaccines(FMDV), Attenuated vaccines(cholera), vector vaccines(vaccinia), DNA vaccine	15 lectures
Unit II Transgenic plants	Genetic engineering of plants- Methodology. Plant transformation with the Ti plasmid of *A.tumefaciens*, Ti plasmid derived vector system Physical methods of transferring genes to plants- electroporation, microprojectile bombardment, liposome mediated, protoplast fusion. Golden rice, bt cotton and edible vaccines	15 lectures
Unit III Transgenic animals	Transgenic mice- methodology-retroviral method, DNA microinjection, ES method, genetic manipulation with *cre-loxP* recombination system. Cloning live stock by nuclear transfer. Green Fluorescent Protein, Transgenic fish	15 lectures
Unit IV Bioinformatics	Bioinformatics:- Definition, history, scope and applications of bioinformatics. Role of computer, internet, world wide web, NCBI. Database:- Types of databases DNA databases Protein databases Tools :- Web search tools, Data retrieval tools – Entrez databases Heuristic tools in Sequence similarity searching - FASTA and BLAST	15 lectures

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COURSE CODE	TITLE	CREDITS
USBT604	**Industrial Biotechnology**	**2**
Unit I Dairy technology	Milk: Normal flora, changes in raw milk, enumeration. Factorsaffectingbacteriological quality. Preservation methods, Pasteurisation. Starter Cultures. Fermented products-Production process and spoilage- Cheese: Swiss and Cheddar, Butter, Yogurt and Buttermilk	15 lectures
Unit II Environmental Biotechnology	Industrial Waste- Characteristics, Nature, Treatment Types-Dairy, Distillery and Pharmaceutical industry Monitoring criteria- pH, temp, TSS, TDS, TS, BOD, COD and heavy metals Energy sources renewable, non-renewable. Biofuels and biogas Bioremediation- plants and microbes	15 lectures
Unit III Biofertilizers, Biopesticides, and biosensors	Biopesticides and Biofertilizers- Production, application. advantages and limitations Biosensors-principle, working and application	15 lectures
Unit IV IPR ,Quality Assurance, Entrepreneurship	IPR-introduction, Patents, trade secrets copyrights. Plant variety protection. Patenting genes and DNA sequences, genetic resources Management of IPR Patenting related to GMO QA, QC and GMP Entrepreneurship	15 lectures

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PRACTICALS		
COURSE CODE	**TITLE**	**CREDITS**
USBTP07	• Antibiotic sensitivity test using agar cup method, • Antibiotic sensitivity test using paper disc method • Antibiotic sensitivity test using ditch method. • To determine synergistic action of two drugs. • Problems based on : - Standard deviation , Coefficient of correlation, Regression, Z-test , t-test chi-square test • Cholesterol estimation in Serum • Determination of Antigen identity by Ouchterlony and Mancini methods	1
USBTP08	• Sterility checking of injectible. • Extraction of DNA from yeast • Isolation of Normal flora from raw milk and curd • Determination of milk protein • Determination of BOD • Determination of COD • Enrichment and Isolation of *Azotobacter* and biopolymer production • Analysis of milk Methylene blue reduction test (MBRT) Resazurin reduction test (RRT) Phosphatase test for milk • Skill based Project	1

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REFERENCES

Title	Author	Publisher
Cell and Molecular Biology: Concepts and Experiments,	Gerald Karp 5th edition	Wiley International Student Version
Molecular Biology of the Cell	Alberts,B., Bray,D, Lewis,J, Raff,M, Roberts,K, and Watson, J 3rd edition	Garland Publishing, Inc
Biostatistics	P.N.Arora and P.K. Malhan	Himalaya Publishing House
Methods in Biostatistics	Mahajan ,B.K	Jaypee brothers
Textbook of Microbiology	Pelczar, Kreig and Chan 5th edition	Tata Mc Graw Hill
Mims' Medical Microbiology,	Goering, R.V, Dockell, H.M, Zuckerman, M, Roitt, I.M. 5th edition	Elsevier Publications
Medical Microbiology	Jawetz,E.,Brooks,G.E, Melnick,J.L., Butel,J.S, Adelberg, E. A 18th edition	Prentice Hall International
Foundations In Microbiology	Talaro and Talaro Third edition	W.C Brown Publishers
Medical Microbiology	Ananthnarayan 8th edition	Orient Longman
Microbiology	Prescott Harley and Klein 5th edition	Mc Graw Hill
Principles of Biochemistry	Lehninger Nelson and Cox 4th edition	WH Freeman & Co
Biochemistry	Voet & Voet 3rd edition	John Wiley & sons
Introduction to Endocrinology	Chandra S. Negi	PHI learning pvt ltd
Biochemistry and Molecular Biology of Plants	Buchanan, Gruissem and Jones	IK International
Principles of Biochemistry	Lehninger 2nd Ed	Kalyani publications

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Textbook of Medical Physiology	Guyton, A.C and Hall 11th edition	J.E Saunders
Harper's Illustrated Biochemistry	Murray, R.K, Granner, M.D, Mayes, P.A and Rondwell, V.W 27th Edition	Mc Graw Hill
Biochemistry	Satyanarayana 2nd edition	Books and Allied pvt Ltd
Kuby Immunology	Goldsby, R.A, Kindt, T.J and Osborne, B.A, 5th Edition	W.H Freeman and Company
Biochemistry and Molecular Biology	Keith Wilson and John Walker 6th edition	Cambridge University Press
Bioinstrumentation	L. Veerakumari	MJP Publishers
Biophysical chemistry	Upadhyay Upadhyay and Nath	Himalaya Publishing House
Practical Biochemistry, Principles and techniques	Wilson and walker, 5th Edition	Cambridge University Press
Essential i genetics	Peter Russell	Pearson Education
Molecular Biotechnology – Principles and Applications of Recombinant DNA	Glick, B.R, Pasternak, J.J Patten, C.L 3rd edition	ASM press
Biotechnology expanding horizons	BD Singh	Kalyani Publishers
Biotechnology-Fundamentals and Applications	S.S.Purohit 3rd edition	Student edition
Basic Genetics	Harlt,D Friedfelder,D and Snyder,L	Jones and Bartlett Publishers
Bioinformatics- methods and applications Genomics, Proteomics and Drug discovery,	S.C.Rastogi, N. Mendiratta, P.Rastogi 3rd edition	PHL learning Pvt. Ltd.
Applied Dairy Microbiology	Elmer H Marth and James L Steele 2nd edition	Mercel Dekker Inc New York
Microbial Technology	Peppler,H.J and Perlman,D 2nd edition	Academic Press
Microbiology in Health and Disease	Frobisher	WB Saunders and Company
Industrial Microbiology	A.H.Patel 1st edition	Macmillan India
Environmental Biotechnology	S.D. Jogdand	Himalaya Publishing

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(Industrial pollution management)		House
Pharmaceutical Microbiology	Hugo, W.B, Russell, A.D 6th edition	Oxford Black Scientific Publishers
Environmental Biotechnology	Allan Scragg	Oxford University press
Environmental Biotechnology (Basic concepts and applications)	Indushekar Thakur	IK International

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SUGGESTED READING

Semester V

Topic	
Cytoskeleton	http://www.tifr.res.in/~roop/Publications_files/CurrBioMolMotor-Review.pdf
Cell membrane	http://assets.cambridge.org/97805217/04632/excerpt/9780521704632_excerpt.pdf
Medical Biotechnology-Causative organisms	http://www.ajtmh.org/content/77/6_Suppl/181.full.pdf+html
Virology	http://www.cdc.gov/prions/pdfs/tse-in-humans.pdf
Role of Complement in health and disease	Factor H: A Complement Regulator in Health and Disease, and a Mediator of Cellular Interactions Biomolecules 2012, 2 46-75; doi:10.3390/biom2010046 Biomolecules ISSN 2218-273X Anne Kopp, Mario Hebecker, Eliška Svobodová, Mihály Józsi www.mdpi.com/journal/biomolecules/
The endocrine system and its disorders	http://teachers.sduhsd.net/ahaas/Anatomy%20Physiology/Endocrine%20system/AandPendocrineclinicalapplicationswithquestions.pdf.
Disorders of carbohydrate metabolism	REVIEW Dietary carbohydrate: relationship to cardiovascular disease and disorders of carbohydrate metabolism J Mann; European Journal of Clinical Nutrition (2007) 61 (Suppl 1), S100–S111
GC-MS	Principle, Technique and its application in Food Science, REVIEW ARTICLE Syed Zameer Hussain and Khushnuma Maqbool INT J CURR SCI 2014, 13: E 116-126 ISSN 2250-1770
Reterotransposons	www.sciencedirect.com/science/article/pii

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Probes	Probe design, production and applications pdf by M.A de Muro
Fermentation.	http://www.massey.ac.nz/~ychisti/FermentInd.PDF.
Scale up	http://fermentationtechnology.blogspot.com/2008/01/scale-down-in-fermentation-technology.html.
Industrial fermentation	http://www.gitam.edu/eresource/environmental/em_maruthi/industrial.htm
DSP	http://microbiology.ukzn.ac.za/Libraries/MICR304/DOWN_STREAM_PROCESSING.sflb.ashx.

Semester VI

Topic	
Cell signaling and Signal transduction	http://web.mit.edu/9.013/www/lectures/03-04_MS_Neuronal_Receptors.pdf
Cell cycle, apoptosis and cancer	http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3384434/pdf/aging-04-330.pdf http://www.radio.cuci.udg.mx/bch/ES/papers/CellCycleCheck_EncyclopedLifeSci_2002.pdf https://www.roswellpark.edu/sites/default/files/therapeutic_vaccines_for_cancer_review_2014.111_april_7.pdf
Chemotherapeutic agents	http://icmr.nic.in/ijmr/2004/1009.pdf
Biostatistics	http://www.datastep.com/SPSSTutorial_1.pdf
Immunodiagnostics	**Immunodiagnostics**: Major Advances and Future Insights Sandeep Kumar VashistVashist, Biochip Tissue Chip 2013, 3:2 http://dx.doi.org/10.4172/2153-0777.1000105
Role of hormone in heart disease	The Endocrine System and the Heart: A Review Soo S. Rhee, Elizabeth N. Pearce Rev Esp Cardiol. 2011;64:220-31 - Vol. 64 Num.03 DOI: 10.1016/j.rec.2010.10.016

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Lipoproteins	**LIPOPROTEINS** – ROLE IN HEALTH AND DISEASES Edited by Saša Frank and Gerhard Kostner ISBN 978-953-51-0773-6 library.umac.mo/ebooks/b28050137.pdf
Application of Radioisotopes	**Application of Radioisotopes** in Biochemical Analyses: Metal Binding Proteins and Metal Transporters Miki Kawachi, Nahoko Nagasaki-Takeuchi, Mariko Kato and Masayoshi Maeshima http://www.intechopen.com/download/pdf/23692
Next generation sequencing technology	**www.illumina.com/technology/nextgenerationsequencinghtml**
Recombinant vaccines	**Vaccine development using recombinant DNA technology-CAST www.cast.science.org**
Green fluorescent protein	**The Green fluorescent protein Roger.Y.Tsein www.chem.ualberta.ca> resources>gfp**
Transgenic and knock out animals	**www.lab.anhb.uwa.edu.au>tutorials**
Starter cultures	https://www.dairyscience.info/index.php/cheese-starters/49-cheese-starters.html
Bioremediation	http://www.moef.nic.in/downloads/public-information/BioremediationBook.pdf
Biosurfactants	http://www.dli.gov.in/rawdataupload/upload/insa/INSA_1/2000c4de_31.pdf
Filing a patent	http://www.ipindia.nic.in/ipr/patent/manual/HTML%20AND%20PDF/Manual%20of%20Patent%20Office%20Practice%20and%20Procedure%20-%20html/Chapter%203.htm

T.Y.B.Sc.
BIOTECHNOLOGY
SEMESTER V AND VI
REVISED SYLLABUS (CBSGS) 2016-2017

List of You tube videos

Semester V

Topic	
Cytoskeleton	https://www.youtube.com/watch?v=5rqbmLiSkpk
Cell membrane	https://www.youtube.com/watch?v=rR7NOSRyzhM
Medical Biotechnology- Causative organisms	https://www.youtube.com/watch?v=odRyv7V8LAE
Virology	https://www.youtube.com/watch?v=wLoslN6d3Ec
Immunology	**Antigen presentation and processing** https://www.youtube.com/watch?v=LwLYGTS_3EI
Endocrinology	**Mode of action of group two hormones** https://www.youtube.com/watch?v=Nt2r5R0ZO5U
Carbohydrate metabolism	**Photosynthesis Light reaction, Calvin cycle, Electron Transport** https://www.youtube.com/watch?v=wJDlxp17rY4
Instrumentation	**Separation on WBC using Ficoll density gradient centrifugation.** https://www.youtube.com/watch?v=6lsldFFMEhE
Types of fermentors And process control	https://youtu.be/B7LfT7BIYSQ.
Screening inoculums and strain development	https://youtu.be/LYLjlSU7kOg.
Fermentations	https://youtu.be/zqlgFHAPq7E
DSP	https://youtu.be/VKpthcW1llU https://youtu.be/N7vxq948l-U

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Semester VI

Topic	
Cell signaling and Signal transduction	https://youtu.be/qOVkedxDqQo https://youtu.be/ZBSo_GFN3ql
Cell cycle, apoptosis and cancer	https://youtu.be/brXqJlEx1EU https://youtu.be/g1kEDSx23jU https://youtu.be/paw2SUY22_s https://youtu.be/67NhsSGsxC8
Chemotherapeutic agents	https://www.youtube.com/watch?v=cC9kyoAo1ac&list=PLMO1589WRspykVPiy6SqKi3OPKbe9b0El
Immunotechnology	**Complement FixationTest** https://youtu.be/lKAxV0WOaQE?list=PLewW6YqYSNaaqbPQDlxCHvggJaCuoheoF **ELISA** https://youtu.be/lNxZxJtvB94?list=PLewW6YqYSNaaqbPQDlxCHvggJaCuoheoF
Endocrinology	**Mode of action of group one hormones** https://www.youtube.com/watch?v=CaMKuXKZ70g
Lipid metabolism	**Familial hypercholesterolemia** https://www.youtube.com/watch?v=Yanklj65zjs
Instrumentation	**Confocal microscopy** https://www.youtube.com/watch?v=jUAvneBhDcQ
Dairy Technology	Cheese making https://youtu.be/7-s2Kql0CHI
Environment Biotechnology	Biofuels https://youtu.be/ZGmwtDffc74
Biosensors	https://youtu.be/8zbcib44XCc https://youtu.be/mliAE51s618
IPR	Geographical indications - https://youtu.be/0darluNMxk8

T.Y.B.Sc.
BIOTECHNOLOGY
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THEORY EXAMINATION PATTERN

Internal Assessment- 25marks

Sr. no	Particulars	Marks
1	Class test	
	Objective type questions(10)	1/2
	Concept based questions-Answer in one/two sentences (5)	1
	Short notes-answer any two out of three	5
	Total	20
2	Class participation	5

Semester end exam- 75 marks

Sr. no	Particulars
1	No of questions: 5 Questions 1-4 based on each unit Marks per question:15 No of subdivisions per question:2 a- Short answers-one/two sentences (with internal choice) b- Descriptive type (with internal choice) Question-5 medley of all four units-short notes(with internal choice)
	Total-75

Practical examination pattern

Course	USBTP05	USBTP06	Marks	USBTP07	Marks	USBTP08	Marks
Particulars	Major I	Major I	50	Major I	25	Major I	25
	Major II	Major II	50	Major II	25	Major II	25
	Minor I	Minor I	20	Minor I	10	Project (Skill based)	50
	Minor II	Minor II	20	Minor II	10		
	Journal	Journal	20	Journal	10		
	Viva	Viva	20	Viva	10		
	Identification and spots		20	Spots	10		

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 *A.tumefaciens*, 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 – oxcytocin and vasopressin -**1 Lecture;** Thyroid gland – Thyroxine, calcitonin - **2 Lectures;** Parathyroid gland – PTH -**1 Lecture;** Adrenal medulla – epinephrine and norepinehprine -**1 Lecture;** Adrenal cortex – Glucocortocoids - **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

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.

AC –07/07/2023
Item No. – 6.20 (N)

As Per NEP 2020

University of Mumbai

Title of the program

A- P.G. Diploma in Biotechnology } 2023-24
B- M.Sc. (Biotechnology) (Two Year) }
C- M.Sc. (Biotechnology) (One Year) - 2027-28

Syllabus for

Semester- Sem. I & II

Ref: GR dated 16th May, 2023 for Credit Structure of PG

Preamble

1) Introduction

Biotechnology, a multidisciplinary subject has had and will continue to have a major impact on our lives. The technology uses biological sources like cells and their derivatives for applications spanning agriculture aka Green Biotechnology, medicine /Red Biotechnology, textiles, dairy (White Biotechnology), food and pharmaceuticals from marine resources (Blue Biotechnology), packaging, fuels etc. Mankind has witnessed its immense contribution in the last three years, especially some discoveries that revolutionized diagnostics and therapeutics. Personalized medicine, designer genes, CRISPR Cas 9 are increasingly being tested for the benefit of mankind.

Bioremediation however has been successfully implemented for the clean-up of hazardous pollutants as has the use of biopesticides and biofertilizers which have reduced the use and hazards of toxic chemical insecticides and pesticides.

Green Biotechnology has very well addressed the increase in crop productivity, addressing the concerns of malnutrition and starvation. Renewable, and sustainable energy sources for production of biofuels have been the forte of Biotechnology. Marine biotechnology has been exploring the products that can be tapped from aquatic flora and fauna.

Ethical concerns, unseen fears and environmental impacts loom the horizon, nonetheless. An in-depth study of the subject is thus essential to enable understanding the field better and wider, define laws governing the feasibility and approve conduct of research not only for the benefit of mankind but the environment in toto.

2) Aims and Objectives

The course aims at empowering the learner with a knowledge base in processes and applications that would impact and influence existing prototypes of green, blue, red, and white Biotechnology.

After the completion of the course the students will be skilled and equipped with contemporary knowledge in Biotechnology and would be eligible for jobs in varied industrial sectors.

3) Learning Outcomes

The M.Sc. Biotechnology course has been designed based on learning outcome-based curriculum framework. The course covers the fundamental and advanced areas of Biotechnology with a range of core subjects in each semester. Along with providing the traditional biotechnology knowledge, the course also has enough scope for inter- and multi-disciplinary subjects in the form of departmental electives.

This course also caters the skill enhancement needs of the students as well as provides opportunity for collaboration and learning from other disciplines.

Every semester has a practical course for strengthening their skills in designing and conducting experiments in the field of Biotechnology.

4) **Any other point (if any)**

PROGRAMME LEARNING OUTCOMES (PLO) –

After the completion of this programme, the students will be able –

PLO 1 - To identify, formulate, review research literature, analyze, and design experiments and identify the solutions for complex problems using modern tools.

PLO 2 - To apply the knowledge of basic biotechnology to solve complex problems in society.

PLO 3 - To apply reasoning informed by contextual knowledge to assess societal, health, safety, and the consequent responsibilities relevant to the professional biotechnology practices.

PLO 4 - To recognize the need and have ability to engage in independent and lifelong learning in technological change.

PLO 5 - To function effectively as an individual and as a member or leader in diverse teams and in inter- and multi-disciplinary areas.

Scheme of Examination: (THEORY AND PRACTICALS):

a) **Summative assessments (THEORY):**

For 2 credit courses	**25M (45min)**
Q1. Answer any three questions out of six (covering unit I and II)	15M
Q2. MCQ/Match the following/Ture Or False (covering unit I and II)	05M
For 4 credit courses	**50M (1.5h)**
Q1. Answer any 2 questions out of 3 (based on unit I)	10M
Q2. Answer any 2 questions out of 3 (based on unit II)	10M
Q3. Answer any 2 questions out of 3 (based on unit III)	10M
Q4. Answer any 2 questions out of 3 (based on unit IV)	10M
Q5. Write one Essay type answer out of 3 (based on units I-IV)	10M

b) **Formative assessments** (informal and formal tests administered during the learning process).

For 2 credit courses	**25M**
Group tasks/ Assignments/ Quizzes at the time of completion of each unit	15 M
Spoken/oral examination after completion of each unit	10M
For 4 credit courses	**50M**

Open book test/assignments/presentation/quiz/role play/MCQ/problem solving to be designed for each unit

c) **Summative assessments (Practical):**

For 4 credit courses **50M (3 h)**

- Major (20M)
- Minor (20M)
- Journal (5M)
- Viva. (5M)

d) **Formative assessments** (Informal & formal tests administered during the learning process).

Submission of two Assignments poster/presentation (15M each) based on history/discovery/application/ problems based on techniques/experiments Performed **30M**

Viva and/ field visit report **20M**

Sign of HOD
Professor Varsha Kelkar Mane
University Dept of Biotechnology

Sign of Dean,
Professor Shivram Garje
Name of the Faculty: Science

R:_____

Credit Structure of the Program (Sem I, II, III & IV)

MSc. (Biotechnology) Course Structure
Semester I and II

Year	Level	Sem. (2 Yr)	Major		RM	OJT / FP	RP	Cum. Cr.	Degree
			Mandatory*	Electives Any one Credits 4					
I	6.0	Sem I	**Course 1** Biochemistry **Credits 4** **Course 2** Bioprocess Engineering and technology **Credits 4** **Course 3** Practical –Lab work- I **Credits 4** **Course 4** Basics in IPR and Patents **Credits 2**	**Course 1** Immunology **Theory 2 Credits + Practical 2 Credits** **OR** **Course 2** Molecular Diagnostics **Theory 2 Credits + Practical 2 Credits** **OR** Any of MOOCs **Credits 4**	4	-	-	22	**PG Diploma after (3 years degree)**
		Sem II	**Course 1** Bioinformatics & Biostatistics **Credits 4** **Course 2** Plant and Animal Biotechnology **Credits 4** **Course 3** Practical –Lab work-II **Credits 4** **Course 4** Patenting in Biotechnology and Bioethics **Credits 2**	**Course 1** Bio entrepreneurship **Theory 3 Credits+ Practical 1 Credit** **OR** **Course 2** Molecular Biology **Theory 2 Credits + Practical 2 Credits** **OR** Any of MOOCs **Credits 4**	-	4*	-	22	
Cum. Cr. For PG Diploma			**28**	**8**	**4**	**4**	**-**	**44**	

*OJT with emphasis on instrumentation- /primary data collection that can be used for their research projects in subsequent semester

MSc. (Biotechnology) Course Structure
Semester III and IV

Year	Level	Sem (2 Yr)	Major		RM	OJT / FP	RP	Cum. Cr.
			Mandatory*	Electives Any one Credits 4				
II	6.5	Sem III	**Course 1** Nanobiotechnology **Credits 4** **Course 2** Environmental Biotechnology **Credits 4** **Course 3** Practical – lab work **Credits 4** **Course 4** Bioanalytical and Biophysical techniques/ **Credits 2**	**Course 1** Biologics and regulatory affairs **Credits 4** **OR** **Course 2** Applied Virology and Microbiology **Theory 2 Credits + Practical 2 Credits** **OR** Any of MOOCs **Credits 4**	-	-	4	22
		Sem IV	**Course 1** Omics and system biology **Credits 4** **Course 2** Drug Discovery and Clinical Studies **Credits 4** **Course 3** Molecular Enzymology **Credits 4**	**Course 1** Food Biotechnology Credits 4 **OR** **Course 2** Scientific writing and Programing Language **Credits 4** **OR** Any of MOOCs **Credits 4**	-	-	6	22
Cum. Cr.for PG Diploma			26	8			10	44
Cum Cr for 2 Yr PG degree			54	16	4	4	10	88

Sign of HOD Varsha K
Professor Varsha Kelkar Mane
University Dept of Biotechnology

Sign of Dean,
Professor Shivram Garje
Name of the Faculty: Science

Syllabus
MSc. (Biotechnology)
(Sem. I & II)

Semester –I

Course-I Biochemistry **Credit 4**

Course Outcomes:
CO1: to build upon undergraduate level knowledge of biochemical principles.
CO2: Special emphasis on different metabolic structures in correlation to the pathways.

Units	Topics	Credit	No of lectures
Unit-I Glycobiology & Membrane Biochemistry	Glycosylation of Biomolecules - Synthesis N-linked, O-linked, and GPI linked glycoproteins and role of glycosylation. Lipid aggregates: micelles, bilayers, and liposomes- structure, types, preparation, characterization, and therapeutic applications of liposomes. Composition and Architecture of membrane: structural lipids in membranes, membrane bound proteins - structure, properties, and function. Membrane Dynamics: lipid movements, flippase, FRAP, Lipid raft, Membrane fusion. Solubilization of the membrane by using different detergents.	4	15
Unit- II Protein Transport & Membrane Trafficking	Translocation of Secretory Proteins across the ER Membrane, Insertion, Protein Modifications, Folding, and Quality Control in the ER, Protein sorting and export from Golgi Apparatus. Sorting of Proteins to Mitochondria and Chloroplasts. Molecular Mechanisms of Vesicular Traffic, early and later Stages of the Secretory Pathway, Receptor-Mediated Endocytosis. Protein degradation: Ubiquitin-proteasome pathway and lysosomal proteolysis.		15
Unit- III Biochemistry of Nucleic acids	Forces stabilising nucleic acid structures, triple helix. Superhelix topology- linking number, Twist and writhing number, measurement of supercoiling and Topoisomerases. Nucleic acid binding protein – Leucine Zipper, Zinc fingers, OB fold, Beta Barrel, Helix-turn-helix, Helix-loop-helix. Biosynthesis of nucleic acids and inborn errors of nucleic acid Metabolism. **Methodologies for detection:** Protein –Protein and DNA –Protein interactions: Gel retardation assay, DNA foot printing, Yeast 2 Hybrid Method advantages and limitations, yeast split-hybrid and reverse two-hybrid systems, Co-Immunoprecipitation (Co-IP) and Far-Western Blot Analysis.		15
Unit- IV Bioenergetics and	Biosynthesis of Amino acids; phenylalanine, tyrosine, threonine, and methionine. Bioenergetics- coupled interconnecting reactions in metabolism; oxidation of		15

regulation of metabolism	carbon fuels; recurring motifs in metabolism. Integration of central metabolism; entry/ exit of various biomolecules from central pathways, principles of metabolic regulation. Strategies of energy Metabolism: organ specialization- Brain, Muscle, Adipose Tissue, Liver, Kidney. Metabolic Homeostasis		

References

For theory:

1. Stryer, L. (2015). *Biochemistry*. (8th edition) New York: Freeman.
2. Lehninger, A. L. (2012). *Principles of Biochemistry* (6th edition). New York, NY: Worth.
3. Voet, D., & Voet, J. G. (2016). *Biochemistry* (5th edition). Hoboken, NJ: J. Wiley & Sons.
4. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2008).
5. Lodish, H. F. (2016). *Molecular Cell Biology* (8th Ed.). New York: W.H. Freeman.
6. Krebs, J. E., Lewin, B., Kilpatrick, S. T., & Goldstein, E. S. (2014).
7. *Lewin's Genes XI*. Burlington, MA: Jones & Bartlett Learning.
8. Cooper, G. M., & Hausman, R. E. (2013). *The Cell: a Molecular Approach* (6th Ed.). Washington: ASM; Sunderland.
9. Laouini et.al. Preparation, Characterization and Applications of Liposomes: State of the Art. journal of Colloid Science and Biotechnology Vol. 1, 147–168, 2012
10. Watson, James D., Baker, Tania A., Bell, Stephen P. & Gann, Alexander: Molecular biology of the gene. (6th ed.) New York. Pearson Education Inc., 2008. 0-321-50781-9

Course II - Bioprocess engineering and technology **Credit 4**

Course Outcomes: CO1: The objectives of this course are to educate students about the fundamental concepts of bioprocess technology and its related applications, CO 2: prepare them to meet the challenges of the new and emerging areas of biotechnology industry.			
Units	**Topics**	**Credit**	**No of lectures**
Unit-I Basic principles of biochemical engineering	Sources of Microorganisms Used in Biotechnology-Literature search and culture collection supply, Isolation de novo of organisms producing metabolites of economic importance. Strain Improvement- Selection from naturally occurring variants, Manipulation of the genome of industrial organisms in strain improvement Bioreactor design and analysis. Media formulation and optimization methods; sterilization of bioreactors aeration and agitation in bioreactors KLa value (factors affecting and methods of determination).		15
Unit- II Production of proteins from recombinant microorganisms	Principles of Microbial Growth: Batch Fermentation, Fed-Batch Fermentation, Continuous Fermentation Maximizing the Efficiency of the Fermentation Process High-Density Cell Cultures, Increasing Plasmid Stability, Quiescent E. coli Cells, Protein Secretion and Reducing Acetate Bioreactors: Typical Large-Scale Fermentation Systems Two-Stage Fermentation in Tandem Airlift Reactors, Two-Stage Fermentation in a Single Stirred-Tank Reactor, Batch versus Fed-Batch Fermentation, Harvesting Microbial Cells, Disrupting Microbial Cells, Downstream Processing, Protein Solubilization, Large-Scale Production of plasmid DNA	4	15
Unit- III Applications of enzyme technology in food processing	Introduction and scope 1. Enzymes sourced from animals and plants used in food manufacturing technology 2. Enzyme usage in food applications. Mechanism of enzyme function and reactions in food processes 1.Starch-processing and related carbohydrates. 2. Lipases for production of food components: interesterified fat 3. Enzymes in protein modification: hydrolyzed protein 4.Enzymes in bread making - flavour, texture and keeping quality 5. Enzymes in dairy product manufacture 6. Enzymes in fruit and vegetable processing and juice extraction 7.Enzymes in fish and meat processing 8. Beer Production using Immobilized Cell Technology		15
Unit- IV Applications of Microbial technology	1. Microbial biomass production: mushrooms, SCP 2.Fermented foods from: meat and fish, bread, Vegetables (sauerkraut, cucumber), Legumes and Oil, Seeds soya bean fermentations		15

	3. Beverages: a) Stimulant Beverages -coffee, cocoa and tea fermentations b) Alcoholic beverages - Cider production 4. Food additives and supplements: a) Lipids, Nucleosides, nucleotides, and related compounds- Vitamins b) Natural food preservatives- bacteriocins from lactic acid bacteria – production and applications e.g. Nisin c) Microbial production of colours and flavours. d) Polyhydric alcohols: low-calorie sweetener particularly useful for sweetening food products for diabetics e) Microbial exopolysaccharides - Xanthan gum 5. Process Food wastes- for bioconversion to useful products (Compost, biofuels, biomass cheap source of raw material in fermentation etc)		

References:

1. Shuler, M. L., & Kargi, F. (2002). Bioprocess Engineering: Basic Concepts. Upper Saddle River,
   NJ: Prentice Hall.
2. Stanbury, P. F., & Whitaker, A. (2010). Principles of Fermentation Technology. Oxford: Pergamon Press.
3. Bailey, J. E., & Ollis, D. F. (1986). Biochemical Engineering Fundamentals. New York: McGraw-Hill.
4. El-Mansi, M., & Bryce, C. F. (2007). Fermentation Microbiology and Biotechnology. Boca Raton: CRC/Taylor & Francis.
5. Lee, Y. K. (2013). Microbial Biotechnology: Principles and Applications. Hackensack, NJ: World Scientific.
6. Alexander N. Glazer and Hiroshi Nikaido -Microbial Biotechnology: Fundamentals of Applied Microbiology, 2nd Edition
7. Michael Waites and Morgan, Rockney and Highton -Industrial microbiology : An Introduction
8. Robert Whitehurst and Maarten Van Oort - Enzymes in food technology 2nd ed
9. Nduka Okafor Modern industrial microbiology and biotechnology Science Publishers, Enfield, (2007)

Course III – Practical –Lab Work -I **Credit 4**

Course Outcomes:
On successful completion of the course the learner would demonstrate and explain the understanding of the following:
CO1: Fundamentals of biochemistry and analytical techniques
CO2: Correlating the applications of the techniques in real world.

Topics	Credit	No of Hours
1. To prepare Acetate and Phosphate buffers using the Henderson-Hassel Bach equation. 2. Purification of protein by ammonium sulphate fractionation, dialyze and separation. using PAGE CBB/silver staining, Glycoprotein staining. 3. To determine an unknown protein concentration using Biuret, Folin lowry's and Bradford's assay 4. Isolation of genomic DNA from plant/animal source 5. Isolation of cholesterol and lecithin from egg yolks. 6. Paper chromatography of Aminoacids, detection using Ninhydrin 7. Microbial pigment/metabolite: a. production – factors affecting – pH, temp, nutrients, static/ shaker conditions, submerged/ surface. b. extraction – soluble and insoluble pigments- organic solvent extraction and purification. 8. Immobilize an organism / enzyme and detect the conversion of substrate to product. 9. Demonstration of media optimization by Placket Burman test- demonstration 10. Methods for measurement of cell mass: a. Direct physical measurement of dry weight, wet weight, or volume of cells after centrifugation. b. Indirect measurement. c. Turbidity measurements employ instruments to determine the amount of light scattered by cell suspension. 11. Demonstration of Analytical techniques like HPLC, FPLC, GC, GC-MS etc. for measurement of amounts of products/substrates. 12. Quality Assurance in a Biotechnology/food/beverage industry – Field visit and report 13. Method validation for any biochemical test (Accuracy, Limit of Detection, Limit of Quantitation, Specificity, Linearity and range, Ruggedness and Robustness) – Report writing.	4	120

References:

1. Principles and techniques of Biochemistry and molecular biology (7th Ed, 2010) Keith Wilson and John Walker, Cambridge university Press.
2. Biochemistry Laboratory (2nd Ed, 2012) Rodney Boyer, Pearson's Publication.
3. Biochemical Methods, Sadasivam and Manikam(3rd Ed, 2008)New age international publishers,2008.
4. An Introduction to Practical Biochemistry (3rd Edition), David T Plummer, Tata McGraw Hill Publishing Company Limited, 1992.

Course IV - Basics in IPR and Patents **Credits 2**

Course Outcomes: On successful completion of the course the learner would demonstrate and explain the understanding of the following: CO1: basic knowledge on intellectual property rights and their implications in biological research and product development. Co 2: Familiarizing with India's IPR Policy;			
Unit	**Topics**	**Credit**	**No of Lectures**
Unit I **Introduction to IPR**	World Intellectual Property Organization (WIPO) – Functions of WIPO – Membership – GATT Agreement – Paris Convention – TRIPS agreement. Types of IP: patents, trademarks, trade secrets, copyright & related rights, industrial design, geographical indications, Biodiversity importance and legislation, plant variety protection and farmers rights act, traditional knowledge.	2	15
Unit II **Basics of Patent**	Eligibility criteria, concept of novelty, concept of inventive step. Patenting systems- Indian Patent Act and amendments, Process of Patenting, Types of patent applications, Patent Agent, Patent Search, Rights of the patent holder, Assignment and licensing of patents and patent Infringement, case studies.		15

References:

1. Ganguli, P. (2001). Intellectual Property Rights: Unleashing the Knowledge Economy. Tata McGraw-Hill Publishing Company.
2. Karen F. Greif, Jon F. Merz - Current Controversies in the Biological Sciences_ Case Studies of Policy Challenges from New Technologies (Basic Bioethics)-The MIT Press (2007)
3. Padma Nambisan (Auth.) - An Introduction to Ethical, Safety and Intellectual Property Rights
4. Issues in Biotechnology- Academic Press (2017)
5. David Castle - The Role of Intellectual Property Rights in Biotechnology Innovation (2011)
6. Goel, D., & Parashar, S. (2013). IPR, Biosafety and Bioethics. Pearson Education India.
7. Singh, S. S. (2004). The Law of Intellectual Property Rights. Deep and Deep Publications, New Delhi, 96.
8. Talwar Shabana; Intellectual Property Rights in WTO and Developing Countries, Edition 2010,Serials Publications, New Delhi.

Elective Course I Immunology **Credits (Theory) 2**

Course Outcomes:
CO1: This course will provide students with an overview of current developments in different areas of vaccines.
CO2: This will be imperative for students as it will help them to predict about nature of immune response that develops against bacterial, viral or parasitic infection, and prove it by designing new experiments.

Unit	Topics	Credit	No of Lectures
I **Vaccinology**	Active and passive immunization; live, killed, attenuated, subunit vaccines; vaccine technology: role and properties of adjuvants, recombinant DNA and protein based vaccines, plant-based vaccines, reverse vaccinology; peptide vaccines, conjugate vaccines; antibody genes and antibody engineering: chimeric, generation of monoclonal antibodies, hybrid monoclonal antibodies; catalytic antibodies and generation of immunoglobulin gene libraries, idiotypic vaccines and marker vaccines, viral-like particles (VLPs), dendritic cell based vaccines, vaccine against cancer, T cell based vaccine, edible vaccine and therapeutic vaccine.	2	15
II **Antigen-antibody interactions**	Precipitation, agglutination and complement mediated immune reactions; advanced immunological techniques: RIA, ELISA, Western blotting, ELISPOT assay, immunofluorescence microscopy, flow cytometry and immunoelectron microscopy; surface plasmon resonance, biosensor assays for assessing ligand –receptor interaction; CMI techniques: lymphoproliferation assay, mixed lymphocyte reaction, cell cytotoxicity assays, apoptosis, microarrays, transgenic mice, gene knock outs.		15

Elective Course 1 Practical **2 Credits**

1. Preparation and sterility testing of heat killed vaccines.
2. To perform the Dot blot assays
3. Latex bead agglutination / precipitation test for detection of rheumatoid factor (RF)
4. Separation of lymphocytes on Ficoll Histopaque and viability count
5. Study of precipitation reactions- Ouchterlony and Mancini
6. Demonstration of Western blotting
7. Widal test- quantitative
8. RPR (Rapid Plasma Reagin)- kit based
9. Determination of ESR

References

1. Kindt, T. J., Goldsby, R. A., Osborne, B. A., &Kuby, J. (2006). Immunology. New York: W.H. Freeman.
2. Murphy, K., Travers, P., Walport, M., & Janeway, C. (2012). Janeway's Immunobiology. New York: Garland Science.
3. An introduction to Immunology C V Rao Narosa Publishing house

4. Immunology essential and fundamental, Second edition S Pathak & U P Parveen Publishing House
5. Text Book of Medical Biochemistry, Praful Godkar. Bahalani Publishers
6. Immunology, An introduction, fourth edition. Ian R Tizard Thomson
7. Immunology, fifth Ed Goldsby, T J. Kindt, Osborne, Janis Kuby Freeman and company.
8. Immunology, sixth Ed Roitt, Brostoff, Male Mosby, An imprint of Elsevier science Ltd
9. Practical immunology, Frank Hay, 4th Edition , Blackwell Science
10. Medical Microbiology, Anantnaraya

Elective Course II: Molecular diagnostics **Credits (Theory) 2**

Course Outcomes:
CO1: The objectives of this course are to sensitize students about recent advances in molecular biology and various facets of molecular medicine.
CO 3 The course would enable leaners understand different aspects of modern medicine including pre- or post-natal analysis of genetic diseases and identification of individuals predisposed to disease ranging from common cold to cancer.

Unit	Topics	Credit	No of Lectures
Unit I Diagnostic Microbiology	Techniques: Molecular amplification techniques • Target amplification systems • Probe amplification systems • Signal amplification PCR in molecular diagnostics; viral and bacterial detection Quantitation of organisms – internal controls, external standards, calibrators, absolute and relative quantification Identification and classification of organisms using molecular markers- 16S rRNA typing/sequencing Detection and identity of microbial diseases Direct detection and identification of pathogenic organisms/ viruses e.g. TB and HIV Clinical utility of molecular diagnostics tests (NAAT) for Hepatitis and AIDS. Molecular identification of fungal pathogens Pharmacogenetics	2	15
Unit II Functional Genomics and Proteomics	Genomics: Gene expression by SAGE and Functional Microarrays- Construction of microarrays – genomics and genomic arrays, cDNA arrays and oligo arrays and Proteomics its applications, NGS platforms, high and low read sequences Proteomics: Separation and Identification of Proteins 2D-PAGE, isoelectric focusing, Edmand reaction Protein tryptic digestion and peptide mass fingerprinting mass spectrometry, MALDI-TOF Protein Expression Profiling: Protein Microarrays/ Protein chips: Types and applications, Gel-based quantitative proteomics: DIGE 15 (Difference in Gel Electrophoresis) Clinical and biomedical applications of proteomics, Introduction to metabolomics, lipidomics, metagenomics and systems biology.		15

Elective Course II practical : **2 credits**

1. Antimicrobial sensitivity test and demonstration of drug resistance.

2. Identification of microorganisms using biochemical testing (performing) and 16S rDNA sequencing (demonstration)
3. Visit to molecular diagnostic lab/ cytogenetic lab: Report
4. Sample collection, storage and processing in molecular diagnostic labs
5. Photo album of chromosomal abnormalities in normal and disease condition numerical detected by using different probes – centromeric, locus specific, telomeric Structural - Translocations and fusion genes, Detection of inversions and interstitial deletions by SKY, CGH for a disease or cancer.
6. Separation of human serum / plasma proteins / egg white using Native PAGE.
7. Demonstration/ video of 2D PAGE
8. Demonstration of Affinity chromatography

References:

For theory

1. Campbell, I. D. (2012). Biophysical Techniques. Oxford: Oxford University Press.
2. Serdyuk, I. N., Zaccai, N. R., & Zaccai, G. (2007). Methods in Molecular Biophysics: Structure,Dynamics, Function. Cambridge: Cambridge University Press.
3. Phillips, R., Kondev, J., & Theriot, J. (2009). Physical Biology of the Cell. New York: Garland Huang, B., Bates, M., & Zhuang, X. (2009). Super-Resolution Fluorescence Microscopy. Annual Review of Biochemistry, 78(1), 993-1016. doi:10.1146/annurev.biochem.77.061906.092014.
4. Lander, E. (2016). The Heroes of CRISPR. Cell, 164(1-2), 18-28. doi:10.1016/j. cell.2015.12.041.
5. Ledford, H. (2016). The Unsung Heroes of CRISPR. Nature, 535(7612), 342-344. doi:10.1038/535342a.
6. Molecular Imaging Theranostics, 4(4), 386-398. doi:10.7150/thno.8006 Coleman, W. B., & Tsongalis, G. J. (2010). Molecular Diagnostics: for the Clinical Laboratorian. Totowa, NJ: Humana Press.
7. Molecular biology of the cell by Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Rafi, Keith Roberts, and Peter Walter. 5th ed. 2008
8. Molecular Microbiology Diagnostic Principles and practice third edition, David H. Persing and Fred C. Tenover Copyright _ 2016 by ASM Press
9. Methods in Molecular Biology, Vol. 204: Molecular Cytogenetics: Protocols and Applications, Edited by: Y. S. Fan © Humana Press Inc., Totowa, NJ 2001
10. Genome 3 TA Brown Molecular Biotechnology – Principles and applications of recombinant technology, Glick 4th edition 2010
11. Human Molecular Genetics. Tom Strachan and Andrew Read, 2004, 3rd Edition, Garland
12. Introduction to human molecular genetics. Jack Pasternak, 2005, 2nd Edition, Wiley publication.

For Practicals

1. Principles and techniques of Biochemistry and molecular biology (7th Ed, 2010) Keith Wilson and John Walker, Cambridge university Press.
2. Biochemistry Laboratory (2nd Ed, 2012) Rodney Boyer, Pearson's Publication.
3. Biochemical Methods, Sadasivam and Manikam(3rd Ed, 2008)New age international publishers,2008.
4. An Introduction to Practical Biochemistry (3rd Edition), David T Plummer, Tata McGraw Hill Publishing Company Limited, 1992

Course: Research Methodology **Credits 4**

Unit	Topic	Credit	Number of lectures
Course Outcomes: On successful completion of the course the learner would be able to: CO1: Demonstrate knowledge of characteristics of research and research types and processes (reading, evaluating, and developing). Identify, explain, compare, and prepare the key elements of a research proposal/report. CO 2 Describe sampling methods, measurement scales and instruments, and appropriate uses of each. Describe, analyze, and apply computational tools with suitable examples. Describe, Discuss, and evaluate plagiarism and its types.			
I Introduction to Research and its types	Definition and Characteristics of Research: Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Philosophy and validity of research. Objective of research. Various functions that describe characteristics of research such as systematic, valid, verifiable, empirical and critical approach. Research process. Types of Research: Pure and applied research. Descriptive and explanatory research. Qualitative and quantitative approaches. Formulating the Research Problem, Literature Review, Developing the objectives, Preparing the research design including sample Design, Sample size.	4	**15 lectures**
II Data and Methods of Data Collection	Data collection, primary and secondary sources of data, and Selecting a method for data collection. Collection of primary data through questionnaires and schedules. Collection of secondary data, processing, and analysis of data. Sample survey, simple random sampling, stratified random sampling, systematic sampling, cluster sampling, area sampling, and multistage sampling. The pilot survey, measurement and scaling techniques.		**15 lectures**
III Writing & Communication of Research and computer applications	Scientific writing (including Language proficiency), scientific literature comprehension, Art and ethics of writing -steps in writing research paper and/or thesis, writing a research proposal, and patents in Science. Abstract writing. SOP writing for laboratory instruments. Skills of making PowerPoint presentations Statistical data analysis: generating charts/ graph and other features. Introduction to tools: Tools used may be Microsoft Excel, Open office, Microsoft Power Point or similar tools and Application of internet in Research.		**15 lectures**
IV Plagiarism	Introduction to plagiarism, reasons for plagiarism, Types of plagiarism, software used for identifying plagiarism, Plagiarism policies and techniques to avoid plagiarism. Use of open educational resources and licenses under creative commons, use of AI tools (any Current references)		**15 lectures**

Reference Books:

1. Research Methodology – Methods and Techniques, C K Kothari, New Age International.
2. Design and Analysis of Experiments, D C Montgomery, Wiley.
3. Applied Statistics & Probability for Engineers, D C Montgomery & G C Runger, Wiley.

4. Management Research Methodology: Integration of Principles, Methods and Techniques, K N Krishnaswamy, A I Sivakumar and M Mathiranjan, Pearson Education.
5. Conducting educational research -Tuckman, B. W. & Harper, B. E. (2012). Conducting educational research (6th ed.). Lanham, MD: *Rowman* & Littlefield Publishers. (ISBN: 978-1-4422-0964-0)
6. CSIR Guidelines for Ethics in Research and in Governance - CSIR (2019)
7. Ethics in Science Education, Research and Governance- Kambadur Muralidhar, Amit Ghosh, Ashok Kumar Singhvi - INSA (2019)
8. Research Design: Qualitative, Quantitative, and Mixed Methods Approaches by John W. Creswell and J. David Creswell
9. The Craft of Research by Wayne C. Booth, Gregory G. Colomb, and Joseph M. Williams
10. Research Methodology: A Step-by-Step Guide for Beginners by Ranjit Kumar.
11. Research Methodology edited Vinayak Bairagi and Mausami Munot. CRC publication

Semester II

Course I - Bioinformatics and Biostatistics **Credit 4**

Course Outcomes:
On successful completion of the course the learner would demonstrate and explain the understanding of the following:
CO 1: practical training in bioinformatic methods including accessing major public sequence databases, use of different computational tools to find sequences, analysis of protein and nucleic acid sequences by various software packages.

Unit	Topics	Credit	No of Lectures
Unit I Bioinformatics	Bioinformatics basics: Computers in biology and medicine; Introduction to Unix and Linux systems and basic commands; Biological XML DTD's; databases and search tools: biological background for sequence analysis, NCBI- publicly available tools; resources at EBI; DNA sequence analysis: gene bank sequence database; submitting DNA sequences to databases, pairwise alignment techniques: BLAST and FASTA, motif discovery and gene prediction; local structural variants of DNA, their relevance in molecular level processes, and their identification; assembly of data from genome sequencing	4	15
Unit II Bioinformatics	Multiple sequence alignment: CLUSTALW and CLUSTALX for multiple sequence alignment, submitting DNA protein sequence to databases: where and how to submit, SEQUIN; submitting aligned sets of sequences, updating submitted sequences; methods of phylogenetic analysis. Protein modelling: Protein structure and classification databases; Protein structure visualization; Protein structure analysis: Secondary, (Chou Fasman algorithm, GOR algorithm, Tertiary (Homology modelling, Threading, Ab initio)		15
Unit III Biostatistics	Introduction and scope of statistics in biological studies and basic concepts. Collection of data, by different sampling methods: Simple random sampling, stratified random sampling and systematic sampling and non-random sampling. Measures of central tendency; Mean, Median and Mode. Measures of Dispersion: Variance/ standard deviation, coefficient of variation and standard error. Confidence limits for mean and proportion. Probability and Basic concepts: Normal and binomial distribution. Correlation and regression analysis for a bivariate data: Scatter diagram		15
Unit IV Biostatistics	Test of Hypothesis: Null hypothesis, alternate hypothesis, test statistics, Type I and Type II errors, level of significance and critical region. Z test: for a single sample, two samples, t-test a single sample, two samples and testing the significance of the correlation. Coefficient: t paired test, Chi-square (x2 test): As a goodness of fit and in 2x2 contingency test		15

References:

1. Lesk, A. M. (2002). Introduction to Bioinformatics. Oxford: Oxford University Press.
2. Mount, D. W. (2001). Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor, NY: Cold
Spring Harbor Laboratory Press.
3. Baxevanis, A. D., & Ouellette, B. F. (2001). Bioinformatics: a Practical Guide to the Analysis of Genes and Proteins. New York: Wiley-Interscience.
4. Pevsner, J. (2015). Bioinformatics and Functional Genomics. Hoboken, NJ.: Wiley-Blackwell.
5. Bourne, P. E., & Gu, J. (2009). Structural Bioinformatics. Hoboken, NJ: Wiley-Liss.
6. Lesk, A. M. (2004). Introduction to Protein Science: Architecture, Function, and Genomics. Oxford: Oxford University Press.
7. S. P. Gupta, Statistical Methods, (45th Revised Edition), Publisher SCHAND
8. William G. Cochran, Sampling Techniques (3th Edition), Wiley and sons
9. Boris V. Gnedenko, Theory of Probability (6th Edition), CRC Press, 13-May-1998
10. Oscar Kempthorne, Klaus Hinkelmann, Design and Analysis of Experiments, Volume1: Introduction
to Experimental Design, 2nd Edition, ISBN: 978-0-471-72756-9 December 2007
11. Acheson Johnston Duncan, Quality Control and Industrial Statistics (5th Edition), Irwin; 5 edition January 1, 1986
12. BK Mahajan, Methods in Biostatistics (7th Edition), Published December 1st 2008 by JP Medical Ltd

Course II - Plant and Animal Biotechnology **Credit 4**

Course Outcomes:
Co 1: Students will be acquainted with the principles, practices and application of animal biotechnology, plant tissue culture, plant and animal genomics, genetic transformation and molecular breeding of plants and animals.

Unit	Topics	Credit	No of Lectures
I Plant tissue culture	Historical perspective; totipotency; culture and organogenesis; Somatic embryogenesis; establishment of Animal cell cultures – callus culture, cell suspension culture, media culture preparation – nutrients and plant hormones; sterilization techniques; applications of tissue culture - micropropagation; somaclonal variation; androgenesis and its applications in genetics and plant breeding; germplasm conservation and cryopreservation; synthetic seed production; protoplast culture and somatic hybridization - protoplast isolation; culture and usage; somatic hybridization - methods and applications; cybrids and somatic cell genetics; plant cell cultures for secondary metabolite production.	4	15
II Plant Genetic manipulations	Genetic engineering: Agrobacterium-plant interaction; Genetic virulence; Ti and Ri plasmids; opines and their manipulations significance; T-DNA transfer; disarmed Ti plasmid; Genetic transformation - Agrobacterium-mediated gene delivery; cointegrate and binary vectors and their utility; direct gene transfer - PEG-mediated, electroporation, particle bombardment and alternative methods; screenable and selectable markers; characterization of transgenics; chloroplast transformation; marker-free methodologies; advanced methodologies - cisgenesis, intragenesis and genome editing; molecular pharming -concept of plants as biofactories, production of industrial enzymes and pharmaceutically important compounds.		15
III Animal cell culture and animal reproductiv eBiotechnology	Brief history of animal cell culture; ATC media: serum, serum free and plant based serum alternatives and chemically defined media.Application of animal cell culture for virus isolation and in vitro testing of drugs, testing of toxicity of environmental pollutants in cell culture, application of cell culture technology in production of human and animal viral vaccines and pharmaceutical proteins. Novel strategies and advancement in mammalian cell line development, large scale production of animal cells, advances in tissue engineering, use of genetic engineering tools for therapy. Animal reproductive biotechnology: structure of sperms reproductive and ovum; cryopreservation of sperms and ova of biotechnology livestock; artificial insemination; super ovulation, and embryo recovery and in vitro fertilization; culture of Vaccinology embryos; cryopreservation of embryos; embryo transfer technology; transgenic manipulation of animal embryos; applications of transgenic animal technology; animal cloning - basic concept, cloning for conservation for conservation endangered species;		15
IV Molecular mapping and marker	Molecular markers - hybridization and PCR based mapping and markers RFLP, RAPD, STS, SSR, AFLP, SNP markers; marker DNA fingerprinting-principles and applications; assisted introduction to mapping of genes/QTLs; marker-assisted selection - strategies for		15

assisted selection.	Introducing genes of biotic and abiotic stress resistance in plants: genetic basis for disease resistance in animals; molecular diagnostics of pathogens in plants and animals; detection of meat adulteration using DNA based methods.		

References:

1. Biology of plant metabolomics, Robert Hall, Annual Plant Reviews, 43, Chichester, West Sussex;Ames, Iowa: Wiley-Blackwell, 2011
2. Plant Biotechnology. Umesha, S. (2013).
3. Glick, B. R., & Pasternak, J. J. (2010). Molecular Biotechnology: Principles and Applications of Recombinant DNA. Washington, D.C.: ASM Press.
4. Brown, T. A. (2006). Gene Cloning and DNA Analysis: An Introduction. Oxford: Blackwell Publishers.
5. Primrose, S. B., & Twyman, R. M. (2006). Principles of Gene Manipulation and Genomics.Malden, MA: Blackwell Pub.
6. Slater, A., Scott, N. W., & Fowler, M. R. (2003). Plant Biotechnology: The Genetic Manipulation of Plants. Oxford: Oxford University Press.
7. Gordon, I. (2005). Reproductive Techniques in Farm Animals. Oxford: CAB International.
8. Levine, M. M. (2004). New Generation Vaccines. New York: M. Dekker.
9. Pörtner, R. (2007). Animal Cell Biotechnology: Methods and Protocols. Totowa, NJ: HumanaPress.
10. Chawla, H. S. (2000). Introduction to Plant Biotechnology. Enfield, NH: Science.
11. Razdan, M. K. (2003). Introduction to Plant Tissue Culture. Enfield, NH: Science.
12. Slater, A., Scott, N. W., & Fowler, M. R. (2008). Plant Biotechnology: n Introduction to Genetic Engineering. Oxford: Oxford University Press.
13. Buchanan, B. B., Gruissem, W., & Jones, R. L. (2015). Biochemistry & Molecular Biology of Plants, Wiley 2002

Course III – Practical –Lab Work -II **Credit 4**

Course outcomes: The aim of this course is
CO 1: to provide practical training in bioinformatic methods including accessing major public sequence databases,
CO 2: use of different computational tools to find sequences, analysis of protein and nucleic acid sequences by various software packages.

1. Topics	Credit	No of Hours
	4	120
2. Using NCBI and Uniprot web resources		
3. Introduction and use of various genome databases.		
4. Sequence information resource: Using NCBI, EMBL, Genbank, Entrez, Swissprot/ TrEMBL, UniProt.		
5. Similarity searches using tools like BLAST and interpretation of results.		
a. Multiple sequence alignment using ClustalW.		
6. Phylogenetic analysis of protein and nucleotide sequences.		
7. Use of gene prediction methods (GRAIL, Genscan, Glimmer) (Demonstration)		
8. Homology modeling		
9. Use of various primer designing and restriction site prediction tools.		
10. Use of different protein structure prediction databases (PDB, SCOP, CATH).		
11. Measures of central tendency: Mean, median and mode for grouped and ungrouped data		
12. Measures of dispersion: Standard deviation for grouped and ungrouped data: standard value for the mean and proportion		
13. Confidence limits for the mean and proportion		
14. Probability: Normal distribution and Binomial distribution use of normal tables		
15. Correlation and Regression: Estimation of correlation coefficient, to fit regression equations from bivariate data		
16. Test of hypothesis: a) Z-test, b) t-test c) x2 test		
17. Prepare culture media with various supplements for plant tissue culture.		
18. Prepare explants from suitable plants for inoculation under aseptic conditions.		
19. Isolate plant protoplast by enzymatic and mechanical methods and attempt fusion by PEG		
20. Culture *Agrobacterium tumefaciens* and attempt transformation of any dicot species.		
21. Undertake plant genomic DNA isolation by CTAB method and its quantitation by visual as well as spectrophotometric methods.		
22. Count cells of an animal tissue and check their viability.		
23. Prepare culture media with various supplements for plant and animal tissue culture.		
24. Prepare single cell suspension from spleen and thymus.		
25. Isolate DNA from animal tissue by SDS method.		
26. Attempt animal cell fusion using PEG.		

Course IV - Patenting in Biotechnology and Bioethics **Credit 2**

Course outcome: **CO1:** The course will provide basic knowledge on intellectual property rights and their implications in biological research and product development; **CO2:** The course will facilitate the students in understanding India's IPR Policy.			
Unit	**Topics**	**Credit**	**No of Lectures**
Unit I Patenting	Patentability of Statutory Provisions Regarding Biotechnological Biotechnology Inventions Under the Current Patent Act 1970 (as Inventions Amended 2005). Interpreting TRIPS in the Light of Biotechnology, Territorial Nature of Patents: From Territorial to Global Patent Regime, Inventions, Feasibility of a Uniform Global Patent, System, Merits and Demerits of Uniform Patent Law, Relevance of the Existing International Patent, Tentative Harmonization Efforts, Implications of Setting up a Uniform World Patent System.	2	15
Unit II Bioethics	Introduction, bioethics in health care- euthanasia, Bioethics artificial reproductive technologies, prenatal diagnosis, genetic screening, gene therapy, organ transplantation. Ethics of clinical research, Bioethics in research – cloning and stem cell research, Human and animal experimentation, Agricultural biotechnology - Genetically engineered food, environmental risk, labeling and public opinion. Bioterrorism.		15

References:

1. Ganguli, P. (2001). Intellectual Property Rights: Unleashing the Knowledge Economy. Tata McGraw-Hill Publishing Company.
2. Karen F. Greif, Jon F. Merz - Current Controversies in the Biological Sciences_ Case Studies of Policy Challenges from New Technologies (Basic Bioethics)-The MIT Press (2007)
3. V. Sreekrishna - Bioethics and Biosafety in Biotechnology-to New Age International Pvt Ltd Publishers (2007)
4. Padma Nambisan (Auth.) - An Introduction to Ethical, Safety and Intellectual Property Rights
5. Issues in Biotechnology- Academic Press (2017)
6. Kshitij Kumar Singh (auth.) - Biotechnology and Intellectual Property Rights_ Legal and Social Implications-Springer India (2015)
7. Talwar Shabana; Intellectual Property Rights in WTO and Developing Countries, Edition 2010, Serials Publications, New Delhi.

Elective Course 1: Bio Entrepreneurship **Credits 3**

Course outcomes:
CO1: Bio-entrepreneurship, an interdisciplinary course, revolves around the central theme of how to manage and develop life science companies and projects.
CO2: The objectives of this course are to teach students about concepts of entrepreneurship including identifying a winning business opportunity, gathering funds and launching a business, growing and nurturing the organization and harvesting the rewards

Unit	Topics	Credit	No of Lectures
Unit I **Innovation and entrepreneurship**	Innovation and entrepreneurship in bio-business Introduction and scope in Bio-entrepreneurship, Types of bio-industries and competitive dynamics between the sub-industries of the bio-sector (e.g. pharmaceuticals vs. Industrial biotech), Strategy and operations of bio-sector firms; Factors shaping opportunities for innovation and entrepreneurship in bio-sectors, and the business implications of those opportunities, Alternatives faced by emerging biofirms and the relevant tools for strategic decision, Entrepreneurship development programs of public and private agencies (MSME, DBT, BIRAC, Make In India), strategic dimensions of patenting & commercialization strategies.	3	15
II **Business strategies**	Bio markets: business strategy and marketing Negotiating the road from lab to the market (strategies and processes of negotiation with financers, government and regulatory authorities), Pricing strategy, Challenges in marketing in bio business (market conditions & segments; developing distribution channels, the nature, analysis and management of customer needs), Basic contract principles, different types of agreement and contract terms typically found in joint venture and development agreements, Dispute resolution skills.		15
Unit III **Finance and accounting**	Business plan preparation including statutory and legal requirements, Business feasibility study, financial management issues of procurement of capital and management of costs, Collaborations & partnership, Information technology		15

Elective Course 1 Practical **1 credit**

1. Case study - Successful Entrepreneurship in Biotechnology/pharma industry - Presentation
2. Project submission on startup ideas and validation, presentation and report writing.
3. Any MOOC related to Biotechnology.

References -

Adams, D. J., & Sparrow, J. C. Enterprise for Life Scientists: Developing Innovation and Entrepreneurship in the Biosciences Scion
Shimasaki, C. D. Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies Academic Press Latest Edition
Onetti, A., & Zucchella, A. Business Modeling for Life Science and Biotech Companies: Creating Value and Competitive Advantage with the Milestone Bridge Routledge Latest Edition
Jordan, J. F. Innovation, Commercialization, and Start-Ups in Life Sciences CRC Press Latest Edition

Elective Course II: Molecular Biology **Credit 2 (Theory)**

Course outcomes: **CO1:** The objectives of this course are to provide students with theoretical and experimental knowledge of molecular biology and tools essential for techniques in molecular biology			
Unit	**Topics**	**Credit**	**No of Lectures**
I Molecular Cloning Methods	Gene cloning – The role of restriction endonucleases, Vectors, Identifying a specific clone with a specific probe, cDNA cloning, Rapid amplification of cDNA ends. The Polymerase Chain Reaction – Standard PCR, Using RT-PCR in cDNA cloning, Real-time PCR. Methods of expressing cloned genes – Expression vectors, Other eukaryotic vectors, Using the Ti plasmid to transfer genes to plants,.	2	15
II Molecular Tools for Studying Genes and Gene Activity	Molecular separations – Gel electrophoresis, 2D-gel electrophoresis, Ion-exchange chromatography, Gel-filtration chromatography, affinity chromatography. Labelled tracers – Autoradiography, Phosphorimaging, Liquid Scintillation Counting, Non-radioactive tracers. Nucleic acid hybridization – Southern blots, DNA fingerprinting and DNA typing, in-situ hybridization, Immunoblots (Western blots). DNA sequencing and physical mapping – Sanger method, Automated DNA sequencing, High-throughput sequencing, Restriction mapping. Site directed mutagenesis. Mapping and quantifying transcripts – Northern blots, S1 mapping, Primer extension, Run-off transcription and G-less cassette transcription. Measuring transcription rates in-vivo – Nuclear run-on transcription, Reporter gene transcription, Measuring protein accumulation *in vivo*. Assaying DNA-protein interactions – Filter binding, Gel mobility shift, DNase and other footprinting, ChIP. Assaying protein-protein Interactions. Finding RNA sequences that interact with other molecules – SELEX, Functional SELEX. Knockout and Transgenics – Knockout mice, Transgenic mice.		15

Elective Practical Course II **2 credits**

1. Extraction of genomic DNA from bacteria using commercial kit.
2. PCR and PCR amplicon clean-up.
3. Extraction and purification of DNA band from agarose gels (gel extraction).
4. Cloning of a gene into a plasmid and transforming it into *E. coli*.
5. Restriction digestion and ligation.
6. Expression of cloned gene using an inducer.
7. Chromatin immunoprecipitation (ChIP).

References :

1. Molecular Biology (5th Edition) – Robert Weaver.(McGraw Hill)
2. Molecular Biotechnology- Glick and Pasternak ASM Press.
3. Cell and Molecular Biology- Concepts and Experiments—Karp – Wiley International.
4. Molecular Cell Biology Fifth Edition by Lodish *et al* W. H. Freeman (2003)

Semester	Programme Code	Programme Name	Course Name	Compulsory/ Elective	Theory Marks(Internal)	Theory Marks(External)	Practical Marks(Internal)	Practical Marks(External)	Project Marks(Internal)	Project Marks(External)	Total Marks	Credit
I	1501121	M.Sc. (Biotechnology)	Biochemistry	Compulsory	50	50	--	--	--	--	100	4
I	1501121	M.Sc. (Biotechnology)	Bioprocess Engineering and	Compulsory	50	50	--	--	--	--	100	4
I	1501121	M.Sc. (Biotechnology)	Practical –Lab work- I	Compulsory	--	--	50	50	--	--	100	4
I	1501121	M.Sc. (Biotechnology)	Basics in IPR and Patents	Compulsory	25	25	--	--	--	--	50	2
I	1501121	M.Sc. (Biotechnology)	Immunology	Elective	25	25	25	25	--	--	100	4
I	1501121	M.Sc. (Biotechnology)	Molecular Diagnostics	Elective	25	25	25	25	--	--	100	4
I	1501121	M.Sc. (Biotechnology)	Any of MOOCs	Elective	--	--	--	--	50	50	100	4
I	1501121	M.Sc. (Biotechnology)	Research Methodology	Compulsory	50	50	--	--	--	--	100	4
										Total	550	22

II	1501122	M.Sc. (Biotechnology)	Bioinformatics & Biostatistics	Compulsory	50	50	--	--	--	--	100	4
II	1501122	M.Sc. (Biotechnology)	Plant and Animal Biotechnology	Compulsory	50	50	--	--	--	--	100	4
II	1501122	M.Sc. (Biotechnology)	Practical –Lab work - II	Compulsory	--	--	50	50	--	--	100	4
II	1501122	M.Sc. (Biotechnology)	Patenting in Biotechnology	Compulsory	25	25	--	--	--	--	50	2
II	1501122	M.Sc. (Biotechnology)	Bioentrepreneurship	Elective	25	25			25	25	100	4
II	1501122	M.Sc. (Biotechnology)	Molecular Biology	Elective	25	25	25	25	--	--	100	4
II	1501122	M.Sc. (Biotechnology)	Any of MOOCs	Elective	--	--	--	--	50	50	100	4
II	1501122	M.Sc. (Biotechnology)	OJT	Compulsory	--	--	--	--	50	50	100	4
										Total	550	22

Dr. Varsha Kelkar - Mane
Head of the Department
University Dept. of Biotechnology
University of Mumbai

Letter Grades and Grade Points:

Semester GPA/ Programme CGPA Semester/ Programme	% of Marks	Alpha-Sign/ Letter Grade Result
9.00 - 10.00	90.0 -100	O (Outstanding)
8.00 - < 9.00	80.0 < 90.0	A+ (Excellent)
7.00 - < 8.00	70.0 < 80.0	A (Very Good)
6.00 - < 7.00	60.0 < 70.0	B+ (Good)
5.50 - < 6.00	55.0 < 60.0	B (Above Average)
5.00 - < 5.50	50.0 < 55.0	C (Average)
4.00 - < 5.00	40.0 < 50.0	P (Pass)
Below 4.00	Below 40.0	F (Fail)
Ab (Absent)	-	Absent

Varsha M

Sign of HOD

Professor Varsha Kelkar Mane

University Dept of Biotechnology

Syllabus
P.G. Diploma in Biotechnology
(Sem. I & II)

Team for Creation of Syllabus

No	Name	College Name	Sign
1	Prof Varsha Kelkar Mane	UD Biotechnology	
2	Dr Bhupendra Pushkar		
3	Dr Rohan Gavankar	VIVA College	
4	Dr Bhuvaneshwari Krishna	CHM College	
5	Ms Rashmi Bhave	Gogate Jogalekar College	
6	Dr Shilpa Gharat	Sonopant Dandekar College	
7	Dr Shailaja Palan		
8	Dr Sonal Upadhyay	Vikas College	
9	Dr Namrata Desai	ICLES' Motilal Jhunjhunwala College	
10	Ms Archana Tajane	BNN College	
11	Dr Ganesh Lad	Thakur Shyamnarayan Degree College	
12	Mr Chetan Patil	R.D. and S.H. National College and S.W.A. Science College	
13	Dr Mukesh Pimpliskar	KME's G M Momin Women's college	
14	Dr. Shobha Gupta	Vidyavardhini's Annasaheb Vartak College	
15	Ms Shweta Khopde	MVLU College	
16	Mrs Vaishalee Chaudhari	N. B. Mehta Science College	
17	Ms Vinaya Jategaokar	VES college	

Sign of HOD	Sign of Dean
Name of the Head: Professor Varsha Kelkar Mane Name of the Department: Biotechnology	Name of the Dean: Prof S S Garje Name of the Faculty: Science

Justification for M.Sc.(Biotechnology)

1.	Necessity for starting the course:	**AMultidisciplinary field that integrates biological sciences with technology.Its emerging applications in diagnostics and therapeutics, food and environment have made the subject essential for learners.**
2.	Whether the UGC has recommended the course:	**No**
3.	Whether all the courses have commenced from the academic year 2023-24	**Yes (NEP course has commenced from 2023-24)**
4.	The courses started by the University are self-financed, whether adequate number of eligible permanent faculties are available?:	**Self-financed Permanent faculty available in partial strength**
5.	To give details regarding the duration of the Course and is it possible to compress the course:	**Course duration: 02 years Completion of one year would yield diploma**
6.	The intake capacity of each course and no. of admissions given in the current academic year:	**20**
7.	Opportunities of Employability / Employment available after undertaking these courses:	**Research positions in Institutes and Managerial positions in healthcare, personal care industry, Faculty in colleges, Schools, Scientific writers Scientific assistant/officer/Medical representatives/Entrepreneurs etc**

Sign of HOD Varsha
Professor Varsha Kelkar Mane
University Dept of Biotechnology

Sign of Dean,
Professor Shivram Garje
Name of the Faculty: Science

AC_____

Item No. _____

UNIVERSITY OF MUMBAI

Program : M.Sc. Biotechnology

Course : M.Sc. Biotechnology

Syllabus for Semester: III & IV

(Choice Based and Credit System with effect from the Academic year 2020-21)

University of Mumbai

No. UG/ 95 of 2020-21

CIRCULAR:-

Attention of the Principals of the Affiliated Colleges, the Head of the University Departments and Directors of the recognized Institutions in Science & Technology Faculty is invited to the syllabus uploaded Academic Authority Unit which was accepted by the Academic Council at its meeting held on 27th February, 2013 vide item No.4.67 relating to the revised syllabus as per the (CBSGS) for the M.Sc.(Part-II) (Sem. III & IV) in Bio-Technology.

They are hereby informed that the recommendations made by the Ad-hoc Board of Studies in Bio-Technology at its meeting held on 6th May, 2020 and subsequently made by the Board of Deans at its meeting held on 20th July, 2020 have been accepted by the Academic Council at its meeting held on 23rd July, 2020 vide item No.4.104 and that in accordance therewith, the revised syllabus as per the (CBCS) of M.Sc. (Part II) (Sem. III & IV) in Bio-Technology has been brought into force with effect from the academic year 2020-21, accordingly. (The same is available on the University's website www.mu.ac.in)

MUMBAI – 400 032
14th September, 2020

(Dr. Vinod Patil)
I/c REGISTRAR

To

The Principals of the affiliated Colleges, the Head of the University Departments and Directors of the recognized Institutions in Science & Technology Faculty. (Circular No. UG/334 of 2017-18 dated 9th January, 2018.)

A.C/4.104/27/07/2020

No. UG/ 95 -A of 2020-21 MUMBAI-400 032 14th September, 2020

Copy forwarded with Compliments for information to:-

1) The I/c Dean, Faculty of Science & Technology,
2) The Chairman, Board of Studies in Bio-Technology,
3) The Director, Board of Examinations and Evaluation,
4) The Director, Board of Students Development,
5) The Co-ordinator, University Computerization Centre,

(Dr. Vinod Patil)
I/c REGISTRAR

AC_____
Item No. _____

UNIVERSITY OF MUMBAI

Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course	M.Sc. (Biotechnology)
2	Eligibility for Admission	B.Sc. (Biotechnology)
3	Passing Marks	40%
4	Ordinances / Regulations (if any)	--
5	No. of Years / Semesters	2 years/ Four semesters
6	Level	P.G. / ~~U.G./ Diploma / Certificate~~ **(Strike out which is not applicable)**
7	Pattern	~~Yearly~~ / Semester **(Strike out which is not applicable)**
8	Status	~~New~~ / Revised **(Strike out which is not applicable)**
9	To be implemented from	From Academic Year 2020-2021

Date: Signature :

Name: **Dr. Anuradha Majumdar** (Dean, Science and Technology)
Dr. Archana Rath (Chairperson, Ad Hoc BOS in Biotechnology)

PREAMBLE

In recent years, there has been a paradigm shift in education in terms of course content and learning outcomes. In keeping with it, the Faculty of Science & Technology, University of Mumbai, has taken a progressive step to align various programs under its purview with the current Higher Education Policy of the Government of India. The present M.Sc. Biotechnology Second Year (Semester III and IV) syllabus has been designed with the idea of incorporating outcome-based-learning for fruitful engagement of learners. The syllabus has undergone several curriculum revision exercise based on the remodeled M.Sc. Biotechnology Curriculum, May 2017, Department of Biotechnology, Ministry of Science and Technology, Government of India. The revised syllabus is an outcome of several rounds of deliberations, discussions, feedback and multiple brainstorming sessions involving various contributors & stakeholders- academicians, researchers, industry experts and students. Course Objectives and Course Outcomes have been clearly defined for each paper in the syllabus to guide teachers in order to make learning process more effective. A lot of focus has been given in the syllabus to cover latest developments in the area of biotechnology and to equip students with necessary knowledge and skills. Relevant papers to make students industry ready have also been included. Attempts have been made to draft a robust, well defined syllabus keeping in view the best learning outcome which shall enable students to pursue high quality research or increase employability of the students. Online course component has been introduced in the curriculum in keeping with the digital initiatives of MHRD to provide good quality self-learning content through MOOCs under SWAYAM and allied platforms.

It is hoped that the revised syllabus shall serve its objective of promoting outcome-based learning to meet the changing needs of the biotechnology sector.

Dr. Anuradha Majumdar **(Dean, Science and Technology)**
Prof. Shivram Garje **(Associate Dean, Science)**
Dr. Archana Rath **(Chairperson, Ad Hoc BOS in Biotechnology)**
Dr. Deepali Karkhanis **(Member)**
Dr. Sneha Panvalkar **(Member)**
Dr. Seema Kokitkar **(Member)**
Dr. Tara Menon **(Member)**
Dr. Jayaprada R. Chunduri **(Member)**
Dr. Bhupendra Pushkar **(Member)**
Dr. Rajesh C. Patil **(Member)**

MSc Biotechnology Course Structure

Semester III

Course code	Title	Theory /Practical	Marks	Credits	Nos of Lectures /week
PSBT 301	Applied virology and microbiology	Theory	100	4	1
PSBT 302	Environmental Biotechnology	Theory	100	4	1
PSBT 303	Biologics and Regulatory Affairs	Theory	100	4	1
PSBT 304	Molecular Enzymology and Enzyme Technology	Theory	100	4	1
PSBTP301	Practical I	Practical	50	2	4
PSBTP302	Practical II	Practical	50	2	4
PSBTP303	Practical III	Practical	50	2	4
PSBTP304	Practical IV	Practical	50	2	4
	TOTAL		**600**	**24**	

MSc Biotechnology Course Structure

Semester IV

Course code	Title	Theory /Practical	Marks	Credits	No. of Lectures/ week
PSBT 401	Nanobiotechnology	Theory	100	4	1
PSBT 402	OMICS & Systems Biology	Theory	100	4	1
PSBT 403	Drug Discovery & Clinical Study	Theory	100	4	1
PSBT 404	Scientific Writing & Food Biotechnology	Theory	100	4	1
PSBTP401	Practical I	Practical	50	2	4
PSBTP402	Practical II	Practical	50	2	4
PSBTP403 & PSBTP404	Practical III & IV	Practical	100	4	8
	TOTAL		**600**	**24**	

Teaching pattern:

One (01) Credit would be of thirty-forty (30-40) learning hours; of this, more than fifty per cent of the time will be spent on classroom instructions including practical as prescribed by the University. Rest of the time would be 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 classroom teaching and 15 lectures as Notional hours/ paper). Each lecture duration would be for 60 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.

Scheme of Examinations:

(a) Internal assessment of 40 marks per course per semester should be conducted.

(b) External assessment of 60 marks per course per semester at the end of every semester

(c) Practical examination of 200 marks should be conducted at the end of every semester.

A. Semester III- Theory -Internal assessment (40%) -40 marks

Sr No	Evaluation type	Marks
1.	Assignments that can include article writing, report writing, preparation of a review, on any topic selected from each paper OR PowerPoint presentation on a topic from the syllabus or related to the syllabus *Note: The student can submit only 2 assignments and give 2 PowerPoint presentations per semester. Respective college/department can decide the allocation.*	30
2.	**a.** Active participation in routine class instructional deliveries	05
	b Overall conduct as a responsible student, w.r.t manners, skill in articulation, leadership qualities demonstrated through organizing co-curricular activities, etc.	05
	Total Marks	40

Semester IV- Theory -Internal assessment (40%) -40 marks

Sr. No	Evaluation type	Marks
1.	**For PAPER 1 & 2** Assignments that can include article writing, report writing, preparation of a review, on any topic selected from each paper OR PowerPoint presentation on a topic from the syllabus or related to the syllabus *Note: The student can submit only 1 assignment and give 1 PowerPoint presentations per semester. Respective college/department can decide the allocation* **FOR PAPER 3:** The students have to present a clinical case/trial study report.	30
2.	**a.** Active participation in routine class instructional deliveries	05
	b Overall conduct as a responsible student, w.r.t manners, skill in articulation, leadership qualities demonstrated through organizing co-curricular activities, etc.	05
	Total Marks	40

Sr. No	Evaluation type	Marks
3.	**FOR PAPER 4:** The internal assessment will comprise of the following: a. Online course: The student is expected to complete at least one online course relevant for the subject from any of the appropriate reputed online platforms. A proof of successful completion of the online course must be provided for the award of marks.	20
	b. Research Proposal: The student is expected to submit a research proposal relevant to the subject.	20
	Total Marks	40

B. Theory -External examination -60%

Semester End Theory Assessment- 60 marks

- The duration of this exam will be of 2.5 hours (150 minutes)
- The theory question paper will have 5 questions each of 12 marks.
- For each unit, there will be one question and the fifth will be based on all the four units.
- The fifth question will have 6 sub-questions out of which the student has to attempt any 3.
- All questions shall be compulsory with internal choice within the questions such that each question will be set of 24 marks with options.

Practical Examination Evaluation scheme (50 marks per paper)

1.	Practical Question 1	25
2.	Practical Question 2	15
3.	Journal	5
4.	Viva Voce	5
	OR	
1.	Practical Question	40
2.	Journal	5
3.	Viva Voce	5
	Semester IV- Project Dissertation	100 Marks
	For semester IV it is mandatory for students to undergo Hands-on Project training in an established research laboratory or college laboratory for 4-6 months; This should involve one or more relevant instrumentation technique. Thesis on the same to be evaluated by the guide alternatively by an internal examiner for 50M based on the student's performance, written matter and experimentation. A certificate must be appended with the thesis. The external examiner will assess for 50M as a Presentation during practical exams. Marks allotted by Internal examiner would be scaled down if required as per university guidelines.	

A certified copy of the journal is essential to appear for the practical examination.

Note:

- In case of any changes in the above-mentioned evaluation scheme, the chairperson of examinations would provide the necessary details and the format.
- The practical examinations at a center would be evaluated by one external examiner assigned by the University and one internal examiner assigned by the college/department.

M.Sc. BIOTECHNOLOGY

SEMESTER- III

PSBT301- Applied Virology & Microbiology				
Course Objectives	Students will be exposed to pandemic diseases, significance of epidemiology in studying various diseases and societal & economic issues related to such diseases. Students will also learn details about emerging viral, bacterial, parasitic pathogens. Students will learn advanced, automated methods for determining antimicrobial susceptibility, drug resistance and various aspects of biofilms.			
Course Outcomes	Students will understand epidemiological principles in prevention, control and management of pandemic disease. They will acquire understanding of antimicrobial resistance for management of drug resistance in population. Students will understand the different aspects of biofilm and their management. They will also get insights into latest development of diagnostics & therapeutics for such diseases.			
Course Code	**Unit**	**Unit Details**	**Credits**	**Lectures**
PSBT302	I Pandemic diseases, pathogenesis, diagnosis and treatment	Introduction to Pandemic diseases and causative agent like H1N1, MERS, SARS, Swine flu, COVID-19, Nipah virus, Ebola virus. Structure of these viruse-coat and envelope protein, genome composition Pathogenesis (Mechanism of infection) and Acute Clinical manifestations (Signs and symptoms) of H1N1, MERS, SARS, Swine flu, COVID-19, Nipah virus, Ebola virus Diagnosis, and Treatment for H1N1, MERS, SARS, Swine flu, COVID-19, Nipah virus, Ebola virus Economic and Social loss due to t Viruses	1	15
	II Epidemiology of infectious diseases	Concept of Host, Reservoir, Source of infection, Carrier , Epidemic, Endemic, Pandemic, Outbreak History , Definition scope, importance of epidemiology Epidemiology, Health & Public Health Epidemiological principles in prevention & control of disease Measures of disease frequency – Concept of incidence, prevalence, Incidence rate, cumulative incidence, case fatality Epidemiological studies Organizations in disease control & Research – WHO, CDC, UNICEF, NACO, ICMR, NARI, NIV & NGOs	1	15

	III Medical Microbiology	Emerging Pathogens / Infections : Diseases caused by Bacteria / parasites/ viruses Name of causative agent, Name of disease caused, History, Antigenic structure, virulence factors, source of infection, Transmission, Pathogenesis, Clinical manifestations, Laboratory diagnosis, Treatment, Prophylaxis, vaccines , Current research and developments Bacteria as emerging pathogens / Diseases caused by bacteria : MOTT, Legionella, Conditions caused by *Helicobacter pylori* Viruses as emerging pathogens / Diseases caused by viruses : HIV (AIDS), Chikungunya, Dengue, Parasites as emerging pathogens / Diseases caused by parasites : Malaria , *Entamoeba histolytica* (Amoebic dysentery)	1	15
	IV Biofilms & Antimicrobial Activity	Structure of Biofilm – Extracellular polymeric substances, Biofilm architecture. Stages in formation of Biofilm. Microbial interactions in Biofilms (Quorum sensing) Need for formation of Biofilms by microorganisms Microorganisms commonly associated with biofilms on indwelling medical devices Response of biofilms to host defense mechanisms & antimicrobial agents Recent advances in biofilm management. Conventional methods of drug susceptibility testing (Kirby-Bauer disc diffusion, Stoke's method, E test) Advanced methods- Macro & Micro broth dilution methods, Time kill curves, serum killing curves, checker-board assays. Detection of drug resistance in Staphylococci, Streptococci, Enterococci. Automated methods of sensitivity testing. Concept of CLSI standards	1	15

PSBTP-301 Practicals

1. Viral Titering – Plaque Assay, Tissue Culture Infectious Dose (TCID), Chicken Embryo Infectious Dose (CEID)
2. Immunoassays: For detection of the virus antigens by ELISA / RIA
3. Detection techniques for COVID like RT- PCR and various RAPID tests
4. Diagnosis of dengue (kit method)
5. Diagnosis of Chikungunya (kit method)
6. Antibiotics susceptibility testing by broth Macro dilution method & Micro broth dilution method
7. Study of microbial biofilm formation on various surfaces & Biofilm visualization by staining
8. Demonstration of minimum biofilm inhibition concentration of antibiotics/disinfectants.

References

1	Microbiology An introduction 10th edition Gerald Tortora, Burdell Funke, Christine Case, pearson Education Inc. Publication 2010
2	Basic Epidemiology R. Bonita, Bealglehole, T. Kjellstrom, 2nd Edition, 2006, WHO
3	Principles of Epidemiology in Public Health Practice, Third edition, US Department of Health & Human Services, CDC, 2012
4	Martin Rusnák, Viera Rusnáková, Georges Kamtoh, RELATIONS BETWEEN EPIDEMIOLOGY AND PUBLIC HEALTH, 2018 https://www.researchgate.net/publication/323964710
5	Evaluation and use of Epidemiological evidence for environmental health risk assessment guideline document World Health Organization 2000 eur/00/5020369
6	Ananthanarayan and Paniker's Textbook of Microbiology, by Reba Kanungo, 10thedUniversities Press; Tenth edition, 2017
7	Koneman's Colour Atlas & Textbook of Diagnostic microbiology, 7th edition, 2017, Lippincott, Williams & Wilkins.
8	Mackie & McCartney Medical Microbiology, J. G. Collee, J. P.Duguid, A. G. Fraser, B. P. Marmion, Thirteenth edition, Churchill Liviingston
9	Bailey and Scotts Diagnostic Microbiology Forbes, Sahem et al 12th ed, Moshby

PSBT302-Environmental Biotechnology				
Course Objectives:		This course aims to introduce learners to latest concepts in environmental biotechnology, various types of pollutions, monitoring, latest mitigation strategies and management of the same. Health hazards of pollution and waste, solid waste management, biodiversity concepts and data management and environmental monitoring.		
Course Outcomes:		At the end of the course, students will be able to understand various concepts of environmental biotechnology, latest development in the area and use of microbiological, molecular and analytical methods in environmental biotechnology.		
Course Code	**Unit**	**Unit Details**	**Credits**	**Lectures**
PSBT 302	I Air	Air pollution & air Quality Monitoring, Sampling, Source Apportionment. Air Pollution Management in Urban Settlement & Rural Areas, Integrated Air Pollution Management, Green Belt. Biofilters/ Bioscrubber. Catalytic Systems. Green Technology. Ozone Layer Depletion Atmospheric Brown Cloud Impact on Flora and Fauna Impact on Crop Yield, concept of carbon credit, footprint.	1	**15**
	II Soil	Causes of soil salinity; Chemical and metallic pollution of agricultural soil; Mining and soil pollution; Soil pollution and air quality; Bioleaching of metals, bioaugmentation & biomagnifcation for soil remediation. Phytostabilization - Contaminant removal, Soil cover, Rhizosphere modification, Geotextile capping solid waste; Industrial solid waste; Domestic solid waste; Agricultural solid waste; Municipal solid waste; Major sources of solid wastes; Effects of solid waste generation on quality of air, water and public health; solid waste management, Disposal of organic and medical waste; Recovery and recycling of metallic waste; Disposal of plastic waste and hazardous wastes.	1	15
	III Water	Biofilms in treatment of waste water; Biofilm development and biofilm Kinetics; Aerobic Biofilms. Marine pollution-major pollutants (heavy metal, pesticide, oil, thermal, radioactive, plastics, litter and microbial, microplastics); Biological indicators (Marine microbes, algae and crustaceans) and accumulators: Biotechnological application of hazardous waste management of water; Use of microbial systems, Phytoremediation strategies in constructed wetlands, Designing constructed wetlands, Substrate, Hydraulic loading rate, Hydraulic retention time, The selection of plant species, Surface area of	1	15

		wetland, Mechanisms to remove pollutants from constructed wetlands		
	IV Biodiversity & Environment Monitoring	Introducing biodiversity informatics, Global patterns of distribution of biodiversity, biomes, Composition and distribution of biodiversity in India, Taxonomic Database Working Group (TDWG) standards, compatibility and interoperatability, taxonomically intelligent systems, Global biodiversity information system-Overview of the UNEP/GEF biodiversity data management project (BDM), Biosensors in Environmental Monitoring – Working & its application for monitoring environment pollutants, Application of protein biomarkers ; Biosensors and biochips. IOT for water quality monitoring – General working, Application, water Parameters	1	15

PSBTP 302-PRACTICALS

1. Soil and water quality assessment (temp, pH, salinity, water holding capacity of soil etc.)
2. Study of metal tolerance of microorganisms isolated from soil/water
3. Soil ecosystem analysis/ analysis of microorganisms of soil
4. Analysis of compost

5. Detection of heavy metals concentration in soil/ water
6. Study and comparison of different air samplers
7. Growth curve of metal tolerant organism isolated from soil/ water.

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2. Karl B. Schnelle & Charles A. Brown, (2002) Air pollution control technology Handbook. CRC Press
3. Singh, R. L. (Ed.). (2017). *Principles and applications of environmental biotechnology for a sustainable future*. Springer Singapore.
4. Enger, E. D., Smith, B. F., & Bockarie, A. T. (2000). *Environmental science: A study of interrelationships* (p. 434). Boston, MA: McGraw-Hill.
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8. Pradhan, A. K., & Pradhan, N. (2015). Microbial biosurfactant for hydrocarbons and

heavy metals bioremediation. In *Environmental Microbial Biotechnology* (pp. 91-104). Springer.

9. Rittmann, B. E., & McCarty, P. L. (2012). *Environmental biotechnology: principles and applications*. Tata McGraw-Hill Education.
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16. Milton fingerman et al. (1999) Recent Advances in Marine Biotechnology Volume 3, AbeBooks Inc.
17. Upadhyay, L. S., & Verma, N. (2015). Role of Biosensors in Environmental Monitoring. In *Environmental Microbial Biotechnology* (pp. 77-90). Springer.
18. Geetha, S., & Gouthami, S. (2016). Internet of things enabled real time water quality monitoring system. *Smart Water*, *2*(1), 1.
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22. Sensen, C. W. (2005). *Handbook of genome research: genomics, proteomics, metabolomics, bioinformatics, ethics and legal issues; Vol. 1 und 2*. Wiley-VCH Verlag GmbH & Co. KGaA.

PSBT303- Biologics & Regulatory Affairs				
Course Objectives:		To introduce learner to the basic concept of Biologics and Biosimilars, and its therapeutic uses To expose learner to the methodologies/steps involved in the production of Biologics/Biosimilars To educate learner with the nuances of characterization of Biosimilars with emphasis on Reference Biologic To familiarize learner with the regulatory aspects of approval of a Biologic/Biosimilar		
Course Outcomes:		At the end of the course, the learner will be: Familiar with the basic concepts and significance of Biologics/Biosimilar in addition to having knowledge about its therapeutic applications Knowledgeable in the steps involved in the production of Biologics/Biosimilars Aware of the protocols/techniques required for characterization of the Biosimilar relative to the Reference Biologic Acquainted with the regulatory aspects of approval of a Biosimilars.		
Course Code	**Unit**	**Paper 3: Biologics & Regulatory Affairs**	**Credits**	**Lectures**
PSBT 303	**Unit 1** **Introduction to Biologics and Biosimilars**	Definition: Drugs, Small molecules, Large molecules/Biologics Categories of Biologics: protein-based hormones, enzymes, monoclonal antibodies, vaccines, blood products, and gene/ cellular therapies. Similarities and Differences: Small molecules versus generics, Biologics versus Biosimilars. USFDA Approved Small Molecules and USFDA Approved Generics USFDA Approved Biologics and USFDA Approved Biosimilars Indian Regulatory Scenario in relation to Small Molecules and Biologics Therapeutic uses of some of the Biologics/Biosimilars Acceptable quality differences between approved Biosimilar and innovator's product	1	15

	Unit 2 **Production of Biologics and Biosimilars**	Reference Biologic and its significance, Choice of expression system/s and stability of cell lines Development of upstream and downstream processes and scale up to manufacturing Major factors contributing to the maintenance of product quality: raw materials and manufacturing conditions, virus filtration, mycoplasma removal, ultrafiltration Example: Production of Monoclonal antibody, downstream processing of Mab Introduction to the concept of Biobetters vs Biosimilars	1	15
	Unit 3 Characterization of Biologics and Biosimilars	Appearance, particulates, pH, osmolality, particle size Molecular Weight, Protein Sequence and/or amino acid composition Glycosylation, Sialylation, Phosphorylation, Acetylation, and Myristoylation, if any Sulfhydryl groups(s) and di-sulphide bridges. Size and Purity on HPLC/ MALDI Isoform pattern. Gel electrophoresis (IEF, SDS PAGE and Native PAGE), Western blot Fluorescence spectrum FTIR spectrum and NMR spectrum Bioassays, characterization using Monoclonal Antibody as an example	1	15
	Unit 4 Quality assurance & regulatory affairs of Biologics and Biosimilars	Introduction to Regulatory Affairs and approvals of Biosimilars, Products approved under the FD&C .PHS/BCPI Act 2009: Innovator Biologics Approval, Biosimilar Pathway, Totality of Evidence, Information required to demonstrate biosimilarity, Interchangeability, Product Switching, Product Naming Global regulatory framework	1	15

PSBT303- Practicals:

1) Electrophoresis {PAGE (native, SDS, reducing, non- reducing)} to characterize the protein with regard to its molecular weight, structure/subunits/SS bonds etc., or for detection of impurities in the product
2) Concentration of protein with Folin Lowry
3) Western blot/dot blot for purity of product demonstration/ dummy sandwich preparation of semi-dry or wet western blot sandwich.
4) HPLC /FTIR/NMR spectrum based theory questions may be asked for interpretation
5) Visit to a facility manufacturing Biosimilar

1. **Biosimilars:** Regulatory, Clinical and Biopharmaceutical Development, Editors: Hiten J. Gutka • Harry Yang • Shefali Kakar, AAPS Advances in the Pharmaceutical, Sciences Series, Volume 34.
2. https://www.fda.gov/drugs/drug-approvals-and-databases/approved-drug-products-therapeutic-equivalence-evaluations-orange-book.
3. https://www.fda.gov/drugs/therapeutic-biologics-applications-bla/purple-book-lists-licensed-biological-products-reference-product-exclusivity-and-biosimilarity.
4. http://nib.gov.in/ NIB-DBT2016.pdf.
5. Biosimilars of Monoclonal Antibodies, A Practical Guide to Manufacturing, Preclinical, and Clinical Development. *Edited by Cheng Liu, Ph.D.,K. John Morrow, Jr., Ph.D.,* Copyright c 2017 by John Wiley & Sons, Inc. All rights reserved. Published by John Wiley & Sons, Inc., Hoboken, New Jersey.
6. Introduction to Biologic and Biosimilar Product Development and Analysis, Karen M. Nagel, AAPS Introductions in the Pharmaceutical Sciences, Editor-in-Chief: Robin M. Zavod, Midwestern University, Downers Grove, IL, USA.
7. Regulatory Requirements of 'Similar Biologics' for Marketing Authorization in India. Review Article. Sharmila *et al.,* International Journal of Drug Regualtory Affairs; 2017, 5(1), 20-24.
8. Introduction to Biosimilars and Regulatory Requirements. Fact Sheet 3. International Federation of Pharmaceutical Manufacturers & Association (Geneva) & International Alliance of Patients Organization (UK).

PSBT304- Molecular Enzymology and Enzyme Technology	
Course Objectives	To get familiarity with the basic concepts of enzymes like enzyme kinetics, catalytic power of enzymes, active site and transition sate, regulatory and allosteric enzymes, on protein enzymes.

	Techniques of enzyme purification and its importance. Need for enzyme engineering and its benefits and applications. Role of enzymes as a diagnostic tool and for industrial applications. Use of enzymes as Biosensors.
Course Outcomes	Enzyme deficiencies and use of enzymes as therapeutics. At the end of the course the student will be aware of the enzyme kinetics, the catalytic power of an enzyme, changes in the active site, and the importance of the transition state. The importance of obtaining enzymes in their pure form and the ways it can be achieved. The need for and methods for enzyme engineering to enhance its activity or half life. The significance of enzymes as diagnostic tools, in therapy, industrial application and as biosensors; and the outcome of enzyme deficiencies.

Course code	Unit	Molecular Enzymology and Enzyme Technology	Credits	Lectures
PSBT304	I **Basic concepts -**	Brief history and introduction; chemical nature and properties of enzymes; **how enzymes work**-mechanism of action; **catalytic power** and specificity of enzymes; types of catalysis; **active site**; **transition state** and evidence for enzyme transition state complementarity; enzyme kinetics – **factors affecting enzyme activity**; enzyme inhibition; enzyme specificity; **regulatory enzymes**, regulation of enzyme activity; **allosteric enzymes** and their kinetic properties; units of enzymes; non protein enzymes; coenzymes and cofactors; isoenzymes; enzyme pattern in diseases.	4	15
	II **Techniques of Enzyme purification and studies/enzyme engineering**	Based on molecular size (Dialysis/ ultrafiltration, density gradient centrifugation, size exclusion chromatography); based on solubility of proteins (Isoelectric precipitation, salting out); based on electric charge (Ion exchange chromatography, Electrophoresis-capillary electrophoresis, 2D electrophoresis); based on adsorption properties (Adsorption and Affinity chromatography). Other techniques: Immobilized metal ion affinity chromatography, Hydrophobic interaction chromatography, Reversed phase chromatography and		15

		Chromatofocusing. Enzyme engineering – Introduction, Objectives, Principles, Examples and Steps involved in enzymes engineering. Random mutagenesis and molecular breeding of DNA. Recent advances in Rational approaches for Enzyme engineering. Applications of enzyme engineering.		
	III **Industrial & medical application of enzymes**	Textile Industry, Detergent Industry , Pulp and Paper Industry , Animal Feed Industry: Enzyme Technology for Detoxification of Mycotoxins in Animal Feed , Phytases for Feed Applications and Leather Industry. Enzyme Applications for Human and Animal Nutrition. Biosensors – Introduction, instrumentation, Types and examples. Enzymes based sensors as diagnostic tools- Biosensors for Blood Glucose, Biosensors for Urea in Blood and Urine, Biosensors for Uric Acid, Biosensors for Arginine, Biosensors for Asparagine, Biosensors for Creatinine, Biosensors for Cholesterol, Allosteric enzyme-based biosensors.		15
	IV **Enzyme deficiencies/diagnostic enzymes/ therapeutics**	Disorders of amino acid metabolism- Phenylketonuria, Alkaptonuria, Homocystinuria. Disorders of carbohydrate metabolism – Galactosemia, Hereditary fructose intolerance, Hereditary lactose intolerance. Disorder of lipid metabolism - Gaucher disease, Fabry disease. Disorders of purine and pyrimidine metabolism- HGPRT deficiency, Adenosine deaminase deficiency, Orotic aciduria. Enzymes in diagnosis of diseases- Liver disorders, Cancer, Cardiac disorders. Role of Other enzymes- Lysozyme, Butyrylcholinesterase and Lipases. Therapeutic uses of enzymes - enzymes in replacement therapy,		15

		enzymes in cancer treatment, enzymes for fibrinolysis, enzymes used for various treatments and enzyme gene therapy.		

PSBTP 304-PRACTICALS

1. Microbial Enzyme production:
   a. Partial purification using ammonium sulphate precipitation.
   b. Dialysis of the salt-precipitated protein.
   c. Assessing the enzyme activity and the protein content.
2. Effect of inhibitors/ chemicals on enzyme activity.
3. Extraction of enzymes from plant sources.
4. Measurement of Enzymatic Activity by Using a Colorimetric Assay.
5. Purification of Acid Phosphatase from Wheat Germ.
6. Enzyme Immunoassays.
   a. Methods for Enzyme Immunoassays.
   b. Non-competitive Solid-phase Enzyme Immunoassay.
   c. Competitive, Solid-phase Enzyme Immunoassay.
7. Determining of Alkaline Phosphatase (ALP) Concentration in Blood Plasma.
8. Measuring Lactase Enzymatic Activity.
9. Screening of new microbial strains for production of enzymes and perform its activity staining (zymogram).
10. To determine Specific activity of α Amylase from different sources.

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1. Lehninger Principles of Biochemistry (4th Ed. Nelson, D., and Cox, M.; W.H. Freeman and Company, New York, 2005.

2. Satyanarayan and Chakrapani, Biochemistry. New Delhi, Elsevier Health Sciences APAC, 2013.

3. Berg JM, Tymoczko JL, Stryer L (2002): Biochemistry, 5th ed., Freeman WH and Co., New York.
4. https://shodhganga.inflibnet.ac.in/ bitstream/10603/100595/7/07_chapter%201.pdf General Introduction to enzymes.
5. https://iopscience.iop.org/ book/978-0-7503-1302-5/chapter/bk978-0-7503-1302-5ch1 Introduction to enzymes and their applications.
6. Biochemistry by Lehninger, 2nd Ed, Kalyani publication 2008.
7. Understanding enzymes (3rd edition). Edited by Trevor Palmer, Ellis Horwood, Chichester, 1991.
8. Protein purification principles, High Resolution Methods, and Applications, 3rd Edition, Jan-Christer Janson. John Wiley & Sons, Inc., Hoboken, New Jersey.
9. https://www.biotecharticles.com/ Applications-Article/Methods-of-Purification-of-Enzymes-583.html
10. https://www.creative-enzymes.com/service/enzyme-purification_307.html Enzyme Purification
11. http://web.sungshin.ac.kr/~spark/class/enzchem/EnzChem_ch02.pdf Chapter 2 - purification of enzymes
12. https://www.labome.com/method/Protein-Purification.html
13. http://www1.lsbu.ac.uk/water/enztech/index.html Chapter 6 Enzyme preparation and use

14. https://docplayer.net/20937505- Protein-purification-nison-sattayasai-khon-kaen-university-thailand-1-introduction-2-extraction-of-protein.html
15. http://www.processdevelopmentforum.com/ppts/posters/ Protein_purification_methods-_overview,_29155460.pdf
16. https://www.researchgate.net/publication/281102215_ How_to_purify_proteins.
17. Fundamentals of Enzyme Engineering, Young Je Yoo, Yan Feng, Yong-Hwan Kim, Camila Flor J. Yagonia, : Springer Netherlands 2017.

M.Sc. BIOTECHNOLOGY

SEMESTER- IV

PSBT401- Nanobiotechnology				
Course Objectives	The course aims at providing a general and broad introduction to multi-disciplinary field of nanotechnology. It will familiarize students with the synthesis and applications of nanomaterials in the field of medicine. The course will also give an insight into complete systems where nanotechnology can be used to improve our everyday life.			
Course Outcomes	Students should be able to understand the basic science behind the properties of nanomaterials and the principles behind advanced experimental techniques for studying nanomaterials. Also understand the different aspects and applications of nanomaterials.			
Course Code	**UNIT**	**Unit Details**	**Credits**	**Lectures**
PSBT401	I Introduction to nanotechnology and nanomaterials	Introduction: Nanotechnology, Nature's biological pathway, Examples of nanomaterials and nanostructures found in nature. Nanometer-scale materials: Nanometer-Scale Metals Nano Metal Oxides, Nanopolymers, Quantum Dots, Carbon nanostructures. Nanorobotiocs devices of nature ATP synthase, the kinesin, myosin, dynein, flagella modulated motion.	1	15
	II Synthesis of Nanomaterials	Synthesis of nanometer-scale materials- Top down and Bottom up approaches. Self-Assembly of nanoparticles and its mechanism. Bio-directed synthesis and assembly of nanomaterials Synthesis and Assembly of Nanoparticles and Nanostructures Using Bio-Derived Templates	1	15
	III Nanotechnology in drug delivery	Biological Barriers to Nanocarrier-Mediated Delivery of Therapeutic and Imaging Agents, Nano-Sized Carriers for Drug Delivery, nano enabled drug delivery system, nanorobotics in medicine, Nanomedicine: biopharmaceutics, implantable materials, implantable chemicals, surgical aids	1	15
	IV	Applications of Nanomaterials.	1	15

	Applications of nanotechnology and Nanotoxicology	Nanotoxicology: Unique Properties, Toxicity of Nanomaterials, Factors Responsible for the Nanomaterial Toxicity, Routes of Exposure, Mechanisms of Nanoparticle Toxicity, In Vitro Testing Methods for Nanomaterials, Ecotoxicity Analyses of Nanomaterials		

PSBTP 401-Practicals:

1. Biosynthesis and characterization of eco-friendly silver nanoparticles by using plant/leaf extracts/green tea
2. Synthesis and characterization of zinc sulfide nanoparticles by A reverse micelle method
3. Synthesis and characterization of Fluorescent Carbon Nanoparticles from Candle Soot and its separation of using the Thin-Layer Chromatographic Method
4. Synthesis of alginate beads and investigation of citric acid release from a nanoshell coating of polymer
5. Antimicrobial activity testing of Nanoparticles/nanocomposites

References:

1. Poinern, Gerrard Eddy Jai. A laboratory course in nanoscience and nanotechnology. CRC Press, 2014.
2. Guozhong, Cao. Nanostructures and nanomaterials: synthesis, properties and applications. World scientific, 2004.
3. Sulabha K. Kulkarni (auth.) - Nanotechnology_ Principles and Practices-Springer International Publishing (2015)
4. Crookes-Goodson, W. J., Slocik, J. M., & Naik, R. R. (2008). Bio-directed synthesis and assembly of nanomaterials. Chemical Society Reviews, 37(11), 2403-2412
5. Chad A. Mirkin, Christof M. Niemeyer - Nanobiotechnology II_ More Concepts and Applications-Wiley-VCH (2007)
6. Christof M. Niemeyer, Chad A. Mirkin (Editors) - Nanobiotechnology_ Concepts, Applications and Perspectives-Wiley-VCH (2004)
7. Chad A. Mirkin, Christof M. Niemeyer - Nanobiotechnology II_ More Concepts and Applications-Wiley-VCH (2007)
8. Oded Shoseyov, Ilan Levy NanoBioTechnology_ BioInspired Devices and Materials of the Future (2008, Humana Press)
9. Textbook of Nanoscience and Nanotechnology by B.S. Murty, P. Shankar, Baldev Raj, B B Rath, James Murday
10. Arun Kumar - Nanomedicine in drug delivery-CRC Press _ Taylor & Francis (2013).
11. Yuliang Zhao, Zhiyong Zhang, and Weiyue Feng - Toxicology of Nanomaterials-Wiley-VCH (2016)
12. Diwan, Parag, and Ashish Bharadwaj, eds. The Nanoscope: Encyclopedia of Nanoscience and Nanotechnology. Pentagon Press, 2005. (Vol 1-6)

PSBT 402-OMICS AND SYSTEMS BIOLOGY	
Course objective:	Bring awareness of the emerging fields of OMICS and Systems Biology, biological systems as a whole and how parts of a systems interact with each other To introduce the techniques involved in Genomics, Proteomics, transcriptomics, Lipidomics and Metabolomics. To describe the key features of human genome project To understand the applications of the different OMICS technology to screening, testing and treatment of human diseases . Perturbation of biological systems to study various responses in the biological systems using high throughput techniques. Introduction to the modellling systems , databases ,computational tools used in systems biology Data mining: The unit aims at introducing the concept of knowledge discovery process, data mining methods and various scientific application of data mining. The unit also explores application of systems biology in different field of health care.
Course outcome:	**At the end of the course learners will be able to** Understand how the data is generated by OMICS technologies to contribute to different databases. Understand , compare and contrast the techniques involved in Genomics, Proteomics, transcriptomics, Lipidomics and Metabolomics. Will be able to apply the different technologies of OMICS to the screening, testing and treatment of human diseases . Understand the structure and dynamics of a systems as a whole . Apply the different approaches to study systems biology by top down and bottom up approach. Introduction to concepts of knowledge discovery process and data mining methods. Understand the application of data mining in genomics , proteomics and development of tools in bioinformatics. Have the knowledge of applications of systems biology in development of personalized medicine, drug development.

Course Code	UNIT	OMICS AND SYSTEMS BIOLOGY	credits	lectures (hours)
PSBT 402	I OMICS- the OMICS technology , a broad outlook	Tools of Omics. Introduction to Epigenomics Human genome project- goals, conclusions and application. Structural and functional proteomics- protein- protein interaction and identification of interactions by various methods. Application of Proteomics and Genomics in human diseases –screening, testing and treatment of diseases. Metagenomics: concept, strategies, and applications in environmental biotechnology, agriculture and health	1	15
	II Transcriptomics, Lipidomics And Metabolomics	Introduction to Transcriptomics, Lipidomics And Metabolomics, Glycomics, Pharmacogenomics Techniques used in Lipidomics- Mass Spectroscopy, TLC, HPLC, GC and Capillary electrophoresis, MALDI. Technique used in Metabolomics- Mass Spectroscopy, Electrophoresis, chromatography- GC, LC & NMR. Technique used in Transcriptomics- next generation sequencing, northern blotting, DDRT-PCR, microarrays, gel free assays like biolayer interference, SPR. Applications of transcriptomics metabolomics and lipidomics in human diseases –screening, testing and treatment of diseases.(in clinical applications, personalised medicine, infectious diseases)	1	15
	III Introduction to systems biology	Systems biology towards systems level understanding of biological systemsSystems structure, systems dynamics,systems design and control, systems project Models and Modelling systems in systems biology What is a model? Key properties of models,Basic of computational models, networks, data integration, standards, and model organism Perturbation of biological systemsand 'Omics' as Quantitative high throughput experimental tools for systems biology Standards and formats for systems biologyComputational Databases and software	1	15

		tools in systems biology. Biological networks: metabolic networks, gene regulatory networks, PPI networks, genetic interaction (GI) networks, and signaling networks	1	
	IV Data mining and application of systems biology	Introduction to Knowledge of discovery in databases (KDD) What is knowledge, need for KDD,KDD process outline, concept and goals. Data Mining methods: Statistics – classification, correlation, association analysis, regression, and clustering Machine learning –Symbolic and statistical approaches. Text mining, and Pattern evaluation. Data mining in scientific applicationsApplication of systems biology : 1. Systems biology to systems medicine. 2. Application of systems biology in drug discovery and development 3. Systems biology and synthetic biology		15

PSBTP 402-PRACTICALS :

1. Gel electrophoresis of lipids (lipoproteins exrtacted from various sources) to separate and identify the lipid fraction
2. Preparation of report based on -Databases and data repositories used in systems Biology
3. Detection assay for gene expression using micro array and qRT –PCR (demonstration)
4. Identification of protein using analytical technique Mass spectroscopy (demonstration)

REFERENCES-

Sr no	Title of the book	Author	Publisher
1.	Bioinformatics and functional genomics (2003)	Jonathan Pevsner	John wiley & sons Publications
2.	Integration of omics approaches and systems biology for clinical applications	Antonia Vlahou, Harald Mischak, Jerome Zoidakis, Fulvio Magni.	Wiley publications
3.	Omic technologies : genomics, transcriptomics, proteomics and metabolomics.	Richard P. Horgan And Louise C. Kenny	Scientific advisory committee (sac) , the obstetrician and gynaecologist.
4.	Bioinformatics and functional	Jonathan Pevsner.	Wiley blackwell

	genomics, *third edition*		publications
5.	Concepts and techniques in genomics and proteomics-	Nachimuthu Saraswathy And Ponnusamy Ramalingam.	Biohealthcare publishing (oxford) limited
6.	Intrduction to proteomics- *tools for the new biology- by*	Daniel C. Liebler,	Humana press totowa, nj
7.	Introduction to proteomics principles and applications	By Nawinmishra	John wiley & sons, inc., publication
8.	Multi-omics approaches to disease	Hasin et.,Al;	Genome biology (2017)
9.	The new science of metagenomics	Committee On Metagenomics: Challenges And Functional Applications, National Research Council, Board On Life Sciences	The national academies press. www.nap.edu
10.	Human molecular genetics 4th edition	Tom Strachan And Andrew Read	Garland science
11.	Systems biology a textbook, second edition	Edda Klipp, Wolfram Liebermeister, Christoph Wierling Axel Kowald	Wiley-vch publication
12.	Lipidomics-technologies and applications (2012)	Dr. Kim Ekroos	Wiley wch publications
13.	Topics in current genetics-metabolomics-a powerful tool in systems biology	Jens Nielsen · Michael C. Jewett (Eds)	Springer publications
14.	Foundations of systems biology. First edition	Hiraokikitano(2001)	MIT press, Cambridge
15.	Systems biology	Karthik Raman and Nagasuma Chandra,	Resonance □ February 2010
16.	A new approach to decoding life: systems biology	Trey Ideker	Article *in* annual review of genomics and human genetics · february 2001
17.	systems biology and synthetic biology (2009)	Pengcheng Fu, Sven Panke	Wiley publication
18.	Analysis of biological networks (2008)	Bjorn .Junker, Falk Schreiber	Wiley Interscience
19.	Knowledge discovery and data mining in biological databases	Vladimir Brus I C	The knowledge engineering review, vol. 14:3, 1999
20.	Computational systems biology	Andrieskreite, Roland Eils	Elsevier academic press
21.	Introduction To Biological Networks	Alpan Ravaland Animesh Ray	CRC press(2013)
22.	Advanced systems biology methods in drug discovery and translational biomedicine	Jun Zou	Biomed research international volume 2013

PSBT 403- Drug Discovery and Clinical Studies				
Course Objectives:	The objective of this course is to have a firm foundation in Drug Discovery and Clinical Studies. To provide students knowledge about Clinical Trial Design and Indian Regulations, Pharmacovigilance and Clinical Data Science.			
Course Outcomes:	By the end of the course the student will: Able to learn about drug discovery-design pathway using some in-silico tools. Able to understand the clinical trial design set up as well as they will gain information on rules-regulation and responsibilities in clinical studies.			
Course Code	**Unit**	**Drug Discovery and Clinical Studies**	**Credit**	**Lectures**
PSBT403	**I** **Clinical Research Informatics in Drug Discovery**	Introduction to the drug discovery & development • Source of drugs • Structural effects on drug action • Drugs derived from natural products • General principles of pharmacology • Drug development and testing process **Approaches to new drug discovery** • Computer-aided drug design • Identification of novel drug candidates and drug targets • Construction the signaling network of a drug using integer linear programming • Identification for druggable targets of a disease	1	15
	II **Clinical Trial Design And Indian Regulations**	**Clinical Trial Design** • Basic framework of clinical trial • Randomized clinical trials and different phases • Adaptive randomization methods • Seamless design • Internal pilot design • Design selection factors **Regulations** • The national regulatory body • Key documents in clinical research • Regulatory requirements for the conduct of clinical trials in India **The Roles and Responsibilities of Stakeholders in the Sharing of Clinical Trial Data** • Participants in clinical trials,	1	15

		• Investigators, • Research institutions and universities • Journals and Professional societies		
	III **Pharmacovigilance**	• Scope and purposes of pharmacovigilance • Adverse Drug Reactions (ADR) • ADR classification • Nature and mechanism of ADR • Concept of safety • Phases and types of DATA **The process of Pharmacovigilance** • Signal detection, evaluation and investigation, • Communication **Methods of evaluating effectiveness of action** **International regulatory collaboration** • WHO, CIOMS, ICH, ISoP, ISPE	1	15
	IV **Clinical Data Science**	• Data management in clinical research: An overview • Data Sources and Data Types • Standards in Healthcare Data • Research Data Stewardship for Healthcare Professionals • Preparing Data for Prediction Model Development • Prediction Modeling Methodology • Clinical Decision Support System	1	15

PSBTP 403-PRACTICALS:

1. A finding of a drug-gene interaction or potentially druggable category using The Drug Gene Interaction Database (DGIdb)
2. Recognition of binding patterns common to set of protein structures using ProBiS
3. Recognition of common spatial chemical binding patterns to a Set of Protein Structures using **Multiple** Alignment of Protein **Bind**ing Sites (MultiBind) tool and analysis using RasMol/Jmol
4. Computational protein-ligand docking using AutoDock (DEMO)

REFERENCES

Sr No	Title	Author	Print Details
1	Introduction to Basics of Pharmacology and Toxicology, Volume 1: General and Molecular Pharmacology: Principles of Drug Action, Chapter 3	Gerard Marshall Raj Ramasamy Raveendran, Editors	ISBN 978-981-32-9778-4 ISBN 978-981-32-9779-1 (eBook) https:oi.org/10.1007/978-981-32-9779-1
2	Basic & Clinical Pharmacology, 2017, Fourteenth Edition, Section I, Chapter 1.	Bertram G. Katzung, Editor	ISBN 978-1-259-64115-2 MHID 1-259-64115-5 ISSN 0891-2033
3	Software based approaches for drug designing and development: A systematic review on commonly used software and its applications, Bulletin of Faculty of Pharmacy, Cairo University 55 (2017) 203–210	Prasad G. Jamkhande, Mahavir H. Ghante, Balaji R. Ajgunde	http://dx.doi.org/10.1016/j.bfopcu.2017.10.001
4	Bioinformatics and Drug Discovery, Third Edition, (A Computational Platform and Guide for Acceleration of Novel Medicines and Personalized Medicine, Chapter 10)	Richard S. Larson, Tudor I. Oprea	https://doi.org/10.1007/978-1-4939-9089-4
5	Molecular docking studies, Chapter 5, Shodhganga		
6	Clinical Trial Designs, Indian Dermatol Online J. 2019 Mar-Apr; 10(2): 193–201.	Brijesh Nair	doi: 10.4103/idoj.IDOJ_475_18 PMCID: PMC6434767 PMID: 30984604
7	Experimental designs for small randomised clinical trials: an algorithm for choice.	Catherine Cornu et. al.,	doi: 10.1186/1750-1172-8-48 PMCID: PMC3635911 PMID: 23531234

	Orphanet J Rare Dis. 2013; 8: 48.		
8	Regulatory requirements for clinical trials in India: What academicians need to know, Indian J Anaesth 2017;61:192-9	Nithya J Gogtay, Renju Ravi, Urmila M Thatte	DOI: 10.4103/ija.IJA_143_17
9	Regulatory environment for clinical research: Recent past and expected future, Perspect Clin Res 2017;8:11-6.	Bhave A, Menon S	DOI: 10.4103/2229-3485.198551
10	National Academy Press, Committee on Strategies for Responsible Sharing of Clinical Trial Data; (Chapter 3, The Roles and Responsibilities of Stakeholders in the Sharing of Clinical Trial) Data, Board on Health Sciences Policy; Institute of Medicine. Washington (DC): National Academies Press (US); 2015 Apr 20.	The National Academies Press	International Standard Book Number-13: 978-0-309-31629-3
11	An Introduction to Pharmacovigilance, Second Edition	*Patrick Waller and* Mira *Harrison-Woolrych*	ISBN 9781119289753 (Adobe PDF)
12	Data management in clinical research: An overview, Indian J Pharmacol. 2012 Mar-Apr; 44(2): 168–172.	Binny Krishnankutty, Shantala Bellary, and Latha S. Moodahadu	doi: 10.4103/0253-7613.93842 PMCID: PMC3326906 PMID: 22529469
13	Fundamentals of Clinical Data Science	Pieter Kubben, Michel Dumontier Andre Dekker	ISBN 978-3-319-99712-4 ISBN 978-3-319-99713-1 (eBook) https://doi.org/10.1007/978-3-319-99713-1

PSBT 404-Scientific Writing and Food Biotechnology	
Course Objectives:	The objective of this course is: □ To develop skills for the processing and analysis of scientific data. □ To enable students to present their research results in the format of oral or poster presentations at conferences, to write scientific publications (theses, articles) and to prepare applications for scientific grants (research proposals). □ To inculcate good scientific writing practices.
Course Outcomes:	On completion of the course students will be able to: □ Think critically, organize and analyze scientific data. □ Develop advanced scientific writing skills to write research articles, reviews, thesis, and proposals and to make oral, poster or powerpoint presentations. Understand the best practices of scientific writing by adhering to research ethics and by avoiding plagiarism.

course code		Scientific Writing and Food Biotechnology	credits	lectures
PSBT 404	**Unit I: Basic Scientific Writing and Plagiarism**	Introduction to scientific writing. Basic scientific writing skills: style and language, spelling, grammar, syntax, jargon and sentence structure. Elements of a scientific paper: abstract, introduction, materials & methods, results, discussion, references and drafting titles. Scientific writing process: thinking, planning, rough draft, revision of content. Processing data & application of statistics Displaying data: text, table, graph and defining terms and abbreviations. Statistical analysis and tools for experimental data. Referencing software: Mendeley, Endnote. Plagiarism: Definition, Common types of plagiarism, Intentional and Unintentional plagiarism, Detection of plagiarism by anti-plagiarism tools (Turnitin, Duplichecker, Viper, Copyleaks), Penalties for plagiarism, Avoiding plagiarism.	1	15
	Unit II: Advanced Scientific Writing	Guidelines for Medical writing. Scientific writing skills: Writing a research paper for biomedical journal, Writing science research papers and articles, Writing a research proposal, Writing a research report, Writing popular reports, Writing thesis and dissertation, Writing clinical study reports. Presentation skills: Oral presentation, Poster Preparation & presentation, Powerpoint presentations. Research ethics, Scientific misconduct.	1	15
	Unit III: Food Biotechnology- Nutraceuticals	Nutraceuticals and functional foods Definition, characteristic features, and classification, phytonutraceuticals, Prebiotics and Probiotics, Sources (with examples e.g. microbes, plants, algae, animals), blue biotechnology , food security, food preservation, Chemopreservation Food	1	15

		processing (animal and sea food), food packaging		
	Unit IV: Food biotechnology in management of health and disease	Applications of nutraceuticals in human health and nutrition- health effects of commonly used nutraceuticals and functional foods (case studies), Safety and Regulatory guidelines Nutraceuitcals in management of health and disease Development of designer foods for specific chronic diseases Nutraceutical adjuvants	**1**	**15**

PSBT 404-Practicals

A) Practical: Scientific writing

1. Exploration of various learning platforms in online courses listed below :

a. Online courses in fundamentals of Neuroscience from Harvard University https://online-learning.harvard.edu/course/fundamentals-neuroscience-part-1-electrical-properties-neuron?delta=0

b. Molecular Biology from MIT https://ocw.mit.edu/courses/biology/7-28-molecular-biology-spring-2005/

c. Introduction to Bioethics from Georgetown https://bioethicsarchive.georgetown.edu/phlx101-02/course.html#units/introduction

2. Write a research proposal on any topic of your interest from the MSc syllabus. For research proposal contents and format refer to NSF guidelines.
https://www.nsf.gov/pubs/policydocs/pappg19_1/nsf19_1.pdf
For reference work use Mendeley Desktop.
https://www.mendeley.com/guides/desktop

3. Complete an online course (Minimum 1 week) on the topic related to the biotechnology. Write a comprehensive report on the studied course contents.
a. Swayam https://swayam.gov.in/
b. NPTEL https://nptel.ac.in/noc/
c. MOOC https://www.it.iitb.ac.in/frg/wiki/images/7/7b/Demo-PPT.pdf
d. E-learning https://www.bellevuecollege.edu/elearning/start/intro/

B) Practical: (Food Technology - Nutraceuticals)

1. Estimation of total sugars from food products (dairy, fruit juices, bakery)
2. Determination of acid value of natural fats and oils.
3. Determination of iodine number of fats and oils.

4. Estimation of vitamin B by HPLC (demonstration)
5. Study of nutraceuticals important plants like Zinziber, Curcuma, Alovera, Asparagus, Ocimum etc.
6. Estimation of antioxidant property of phytochemical by DPPH.
7. Qualitative test for tannins, phenols, isoflavones, alkaloids using TLC.
8. Estimation of food preservatives/additives (Parabens) from food sample by HPLC (demonstration).
9. Estimate Cholesterol contents in given sample by Zak's methods.
10. Estimation of bio-burden by viable counts.
11. Estimation of gluten from food sample.
12. To study nutritional components (protein, carbohydrate, secondary metabolites, lipids, vitamin C) of following: Bee honey, Mushrooms, Lentils, Soya, Dairy product, Amla, Papaya, Spinach

References:

1. Thomas, C George. (2019). Research Methodology and Scientific Writing 2nd edition.
2. Kumar, Ranjeet. (2011). Research methodology: a step-by-step guide for beginners 3rd edition.
3. Jennifer Peat, Elizabeth Elliott, Louise Baur, and Victoria Keena. (2002). Scientific Writing (BMJ Books).
4. J.R. Mathews & R.W.Mathews (2008) Successful Scientific Writing, 3rd Ed. Cambridge University Press.
5. https://www.ema.europa.eu/en/documents/scientific-guideline/ich-e-3-structure-content-clinical-study-reports-step-5_en.pdf
6. https://www.emwa.org/documents/about_us/EMWAguidelines.pdf
7. https://www.otago.ac.nz/hedc/otago615367.pdf
8. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3510958/
9. http://medind.nic.in/iad/t02/i1/iadt02i1p21.pdf
10. https://intranet.birmingham.ac.uk/as/registry/policy/conduct/plagiarism/interactive-course.aspx
11. https://www.bowdoin.edu/dean-of-students/judicial-board/academic-honesty-and-plagiarism/common-types-of-plagiarism.html
12. https://www.ox.ac.uk/students/academic/guidance/skills/plagiarism?wssl=1
13. https://holyfamily.libguides.com/c.php?g=610218&p=4236572
14. https://plagiarismdetector.net
15. https://www.duplichecker.com