Academic Council/07/2016
Item No: 4.51

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 membrane, 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 Suceess 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 $NaHCO_3 + Na_2CO_3$ 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 $BaSO_4$ and NH_4Cl 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 & Reduction Reactions**– Oxidising and Reducing Agents, Oxidation Number, Rules to assign Oxidation Numbers with examples Ions like	15 lectures	30 hrs

	Oxalate, Permanganate and Dichromate. 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 Components, 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.

References

1. University General Chemistry , 1st edition (2000), C.N. R. Rao, Macmillan Publishers, India ,
2. Physical Chemistry University for biological sciences, 1st edition, (2005), Chang R., Science Books, USA
3. Essentials of Physical Chemistry, 24th edition, (2000), B S Bahl, G D Tuli, Arun Bahl, S. Chand Limited, India.
4. Concise Inorganic Chemistry .5th edition (2008), Author: J. D. Lee, John Wiley & Sons, USA.
5. Organic Chemistry, 6th edition, (1992), Morrison Robert Thornton, Pearson Publication, Dorling Kindersley (India Pvt. Ltd.)
6. Jordan, E.L. and Verma P.S. 1978, (i) Chordate Zoology S. Chand & Company Ltd. Ram Nagar. New Delhi.
7. Jordan, E.L. and Verma P.S. 1978 (ii) Invertebrate Zoology. S. Chand & Company Ltd. Ram Nagar. New Delhi.
8. Modern Text Book of Zoology: Invertebrates., R.L.Kotpal. Publisher, Rastogi Publications, 2012.
9. Guyton, Text book of Medical Physiology
10. Concise Medical Physiology- Sujit K Chaudhari
11. Human Physiology- Guyton –International Edition
12. Human Anatomy- Marieb
13. Devlin R.M. (1983) - Fundamentals of Plant Physiology (Mac. Millan, New York)
14. Dutta A.C. (2000) A Classbook of Botany (Oxford University Press, UK)
15. Ganguli, Das Dutta (2011) – College Botany Vol I, II and III (New Central Book Agency, Kolkata)
16. Ecology – P.S. Verma and Agarwaal- S. Chand Publications
17. Biotechnology: Environmental Processes- Rehm and Reed- Wiley
18. Molecular Biotechnology- Glick and Pasterman ASM Press
19. Food Microbiology- Frazier
20. Industrial Microbiology- A. H. Patel
21. Industrial Microbiology- L. E. Casida- John Wiley & Sons
22. Introductory Biostatistics. 1st edition. (2003), Chap T. Le. John Wiley, USA
23. Methods in Biostatistics- B. K. Mahajan –Jaypee Brothers
24. Outlines of Biochemistry: 5th Edition, (2009), Erice Conn & Paul Stumpf ; John Wiley and Sons, USA
25. Principles of Biochemistry, 4th edition (1997), Jeffory Zubey, McGraw-Hill College, USA
26. Lehninger , Principles of Biochemistry. 5th Edition (2008), David Nelson & Michael Cox, W.H. Freeman and company, NY.
27. Fundamentals of Biochemistry. 3rd Edition (2008), Donald Voet & Judith Voet , John Wiley and Sons, Inc. USA
28. Biochemistry: 7th Edition, (2012), Jeremy Berg, Lubert Stryer, W.H.Freeman and company, NY
29. An Introduction to Practical Biochemistry.3rd Edition, (2001), David Plummer, Tata McGraw Hill Edu.Pvt.Ltd. New Delhi, India
30. Biochemical Methods.1st , (1995), S.Sadashivam, A.Manickam, New Age International Publishers, India
31. Textbook of Biochemistry with Clinical Correlations, 7th Edition, Thomas M. Devlin, January 2010,
32. Proteins: biotechnology and biochemistry, 1st edition (2001), Gary Walsch, Wiley, USA
33. Biochemical Calculations, 2nd Ed., (1997) Segel Irvin H., Publisher: John Wiley and Sons, New York.
34. Enzymes: Biochemistry, Biotechnology & Clinical chemistry, (2001) Palmer Trevor, Publisher: Horwood Pub. Co., England.
35. Analytical Biochemistry, 3 edition, (1998), David Holmes, H.Peck , Prentice Hall, UK.
36. Culture of Animal cells- Ian Freshney -- John Wiley & Sons
37. Principles and Practice of Animal Tissue culture- Sudha Gangal - University Press

38. Plant Biotechnology- K. G. Ramavat S.Chand Publications
39. Experiments in Plant tissue culture- Dodds and Roberts- Cambridge University Press
40. Microbiology–6th Edition (2006), Pelczar M.J., Chan E.C.S., Krieg N.R., The McGraw Hill Companies Inc. NY
41. Presscott's Microbiology, 8th edition (2010), Joanne M Willey, Joanne Willey, Linda Sherwood, Linda M Sherwood, Christopher J Woolverton, Chris Woolverton, McGrawHil Science Enginering, USA
42. Text book of Medical Microbiology, Anantnarayan
43. Microbiology- Frobisher
44. General Principles of Microbiology- Stanier
45. Fundamental Principles of Bacteriology - A. J. Salle McGraw Hill
46. Genetics, (2006) Strickberger MW - (Prentice Hall, India)
47. Human Genetics- A. M. Winchester – MacMillan Press
48. Kuby immunology, Judy Owen , Jenni Punt , Sharon Stranford., 7th edition (2012), Freeman and Co., NY
49. Textbook of basic and clinical immunology, 1st edition (2013), Sudha Gangal and Shubhangi Sontakke, University Press, India
50. Immunology, 7th edition (2006), David Male, Jonathan Brostoff, David Roth, Ivan Roitt, Mosby, USA.
51. Introduction to Immunology- C V Rao- Narosa Publishing House
52. Cell and Molecular Biology – De Robertis- Lippincott Williams& Wilkins
53. Cell and Molecular Biology- Concepts and Experiments—Karp – Wiley International
54. Essential iGenetics- Peter Russell -Pearson Education
55. Microbial Genetics- Freifelder –Narosa Publishing House
56. Genes XI, 11th edition (2012), Benjamin Lewin, Publisher - Jones and Barlett Inc. USA
57. Molecular Biology of the Gene, 6th Edition (2008), James D. Watson, Pearson Education, Inc. and Dorling Kindersley Publishing, Inc. USA
58. Molecular Biology, 5th Edition (2011), Weaver R., McGraw Hill Science. USA
59. Fundamentals of Molecular Biology, (2009), Pal J.K. and Saroj Ghaskadbi, Oxford University Press.
60. Molecular Biology: genes to proteins, 4th edition (2011), Burton E Tropp Jones& Bartlett Learning, USA