

**UNIVERSITY OF MUMBAI**

**No. UG/19 of 2016-17**

**CIRCULAR:-**

A reference is invited to the Syllabi relating to the B.Sc. degree course, vide this office Circular No. UG/16 of 2016, dated 16<sup>th</sup> June, 2016 and the Principals of affiliated Colleges in Science are hereby informed that the recommendation made by Board of Studies in Science at its meeting held on 18<sup>th</sup> February, 2016 has been accepted by the Academic Council at its meeting held on, 24<sup>th</sup> June 2016 vide item Nos. 4.88 and that the accordance therewith, the revised syllabus of F.Y.B.Sc. (Biotechnology) (Sem. I & II), (Credit Based Semester and Grading System), which is available on the University's web site ([www.mu.ac.in](http://www.mu.ac.in)) and that the same has been brought into force with effect from the academic year 2016-17 which is read as under :-

1. The syllabus of F.Y.B.Sc. (Biotechnology) is re-structured.
2. The Intake capacity of this course as per Govt. of Maharashtra and University of Mumbai's sanction is unchanged.
3. The Eligibility for the course is unchanged.
4. The fees for the course is Rs.30,000/- per years.

MUMBAI – 400 032

27<sup>th</sup> June, 2016

*(Signature)*  
(Dr.M.A.Khan)  
REGISTRAR

To,

The Principals of affiliated Colleges in Science.

**A.C/ 4.88/24/06/2016.**

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No. UG/19 of 2016

MUMBAI-400 032 27<sup>th</sup> June, 2016

Copy forwarded with compliments for information to:-

1. The Dean, Faculty of Science
2. The Director, Board of College and University Development,
3. The Controller of Examinations,
4. The Co-Ordinator, University Computerization Centre.

*(Signature)*  
(Dr.M.A.Khan)  
REGISTRAR

P.T.O.

Academic Council/07/2016

Item No: \_\_\_\_\_

**UNIVERSITY OF MUMBAI**



**Syllabus for F.Y.B.Sc.**

**(Restructured)**

**Programme : B.Sc.**

**Course: Biotechnology**

with effect from the academic year

**2016 – 2017**

**SEMESTER – I**  
**THEORY**

## SEMESTER I

### Basic Chemistry I

COURSE CODE	TITLE	CREDITS	Notional Hours
<b>USBT 101</b>	<b>Basic Chemistry I</b>	<b>2</b>	
<b>Unit I Nomenclature and Classification</b>	<p><b>Nomenclature and Classification of Inorganic Compounds:</b> Oxides, Salts, Acids, Bases, Ionic, Molecular and Coordination Compounds</p> <p><b>Nomenclature and Classification of Organic Compounds:</b> Alkanes, Alkenes, Alkynes, Cyclic Hydrocarbons, Aromatic Compounds, Alcohols and Ethers, Aldehydes and Ketones, Carboxylic Acids and its derivatives, Amines, Amides, Alkyl Halides and Heterocyclic Compounds</p>	15 Lectures	30 hrs
<b>Unit II Chemical Bonds</b>	<p><b>Chemical Bonds:</b></p> <p><b>Ionic Bond:</b> Nature of Ionic Bond, Structure of NaCl, KCl and CsCl, factors influencing the formation of Ionic Bond.</p> <p><b>Covalent Bond:</b> Nature of Covalent Bond, Structure of CH<sub>4</sub>, NH<sub>3</sub>, H<sub>2</sub>O, Shapes of BeCl<sub>2</sub>, BF<sub>3</sub></p> <p><b>Coordinate Bond:</b> Nature of Coordinate Bond</p> <p><b>Non Covalent Bonds:</b> van Der Waal's forces: dipole - dipole, dipole - induced dipole.</p> <p><b>Hydrogen Bond:</b> Theory of Hydrogen Bonding and Types of Hydrogen Bonding (with examples of RCOOH, ROH, Salicylaldehyde, Amides and Polyamides).</p>	15 Lectures	30 hrs
<b>Unit III Water and Buffers</b>	<p><b>Chemistry of Water:</b> 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</p> <p><b>Solutions:</b> Normality, Molarity, Molality, Mole fraction, Mole concept, Solubility,</p>	15 lectures	30 hrs

	<p>Weight ratio, Volume ratio, Weight to Volume ratio, ppb, ppm, millimoles, milliequivalents (Numericals expected).</p> <p><b>Primary and Secondary Standards:</b> Preparation of Standard Solutions, Principle of Volumetric Analysis.</p> <p><b>Acids and Bases:</b> Lowry-Bronsted and Lewis Concepts. Strong and Weak Acids and Bases - Ionic Product of Water - <math>pH</math>, <math>pK_a</math>, <math>pK_b</math>. Hydrolysis of Salts.</p> <p><b>Buffer solutions</b> – Concept of Buffers, Types of Buffers, Derivation of Henderson equation for Acidic and Basic buffers, Buffer action, Buffer capacity. (Numericals expected.) <math>pH</math> of Buffer Solution.</p>		
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## SEMESTER I

### Basic Chemistry II

COURSE CODE	TITLE	CREDITS	Notional Hours
<b>USBT 102</b>	<b>Basic Chemistry II</b>	<b>2</b>	
<b>Unit I Stereochemistry</b>	<p><b>Isomerism</b> – Types of Isomerism: Constitutional Isomerism (Chain, Position and Functional) and Stereoisomerism, Chirality.</p> <p><b>Geometric Isomerism and Optical Isomerism:</b> Enantiomers, Diastereomers, and Racemic mixtures Cis-Trans, Threo, Erythro and Meso isomers. Diastereomerism (Cis-Trans Isomerism) in Alkenes and Cycloalkanes (3 and 4 membered ring)</p> <p><b>Conformation:</b> Conformations of Ethane. Difference between Configuration and Conformation.</p> <p><b>Configuration,</b> Asymmetric Carbon Atom, Stereogenic/ Chiral Centers, Chirality, Representation of Configuration by “Flying Wedge Formula”</p>	15 Lectures	30 hrs

	<b>Projection formulae</b> – Fischer, Newman and Sawhorse. The Interconversion of the Formulae.		
<b>Unit II Titrimetry and Gravimetry</b>	<p><b>Titrimetric Analysis:</b> Titration, Titrant, Titrand, End Point, Equivalence Point, Titration Error, Indicator, Primary and Secondary Standards, Characteristics and examples</p> <p>Types of Titration –Acid –Base, Redox. Precipitation, Complexometric Titration. Acid – Base Titration.-Strong Acid Vs Strong Base -Theoretical aspects of Titration Curve and End Point Evaluation. Theory of Acid –Base Indicators, Choice and Suitability of Indicators.</p> <p><b>Gravimetric Analysis:</b> 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).</p>	15 Lectures	30 hrs
<b>Unit III Analytical Techniques</b>	<p><b>Methods of Separation</b> Precipitation, Filtration, Distillation and Solvent Extraction.</p> <p><b>Analytical Techniques</b></p> <p><b>Chromatography:</b> Definition, Principles, Types Introduction to Paper Chromatography, Thin Layer Chromatography, Column Chromatography and its Applications.</p> <p><b>Colorimetry:</b> Principle, Beer-Lambert's Law, Measurement of Extinction, Derivation of <math>E = kcl</math>, Limitations of Beer-Lambert's Law, Filter Selection</p>	15 Lectures	30 hrs

## SEMESTER I

### Basic Life Science I : Biodiversity and Cell Biology

COURSE CODE	TITLE	CREDITS	Notional Hours
<b>USBT 103</b>	<b>Biodiversity and Cell Biology</b>	<b>2</b>	
<b>Unit I</b> 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 and its Significance  <b>Introduction to Plant Diversity:</b> Algae, Fungi, Bryophyta, Pteridophyta, Gymnosperms and Angiosperms (with one example each)  <b>Introduction to Animal Diversity:</b> Non-Chordates and Chordates {with at least one representative example.)  <b>Introduction to Microbial Diversity</b> Archaeobacteria, Eubacteria, Blue-green Algae, Actinomycetes, Eumycota- Habitats, Examples and Applications.	15Lectures	30 hrs
<b>Unit II</b> Ultra Structure of Prokaryotic and Eukaryotic Cell.	<b>Ultrastructure of Prokaryotic Cell:</b> Concept of Cell Shape and Size. Detail Structure of Slime Layer, Capsule, Flagella, Pili, Cell Wall (Gram Positive and Negative), Cell Membrane, Cytoplasm and Genetic Material Storage Bodies and Spores  <b>Ultrastructure of Eukaryotic Cell:</b> 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 Nucleus –Nuclear Structure, Nucleolus	15Lectures	30 hrs

	External Cell Coverings: Cilia And Flagella Comparison of Prokaryotic And Eukaryotic Cells		
<b>Unit III Bacteria and Viruses</b>	<b>Bacteria</b> : 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  <b>Viruses</b> : General Characters, Classification (Plant, Animal and Bacterial Viruses) Structure and Characterization of Viruses and Significance	15 Lectures	30 hrs

## SEMESTER - I

### Basic Life Science II : Microbial Techniques

COURSE CODE	TITLE	CREDITS	Notional Hours
<b>USBT 104</b>	<b>Microbial Techniques</b>	<b>2</b>	
<b>Unit I Microscopy and Stains</b>	<b>Microscopy and Stains</b> 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
<b>Unit II Sterilization Techniques</b>	Definition : Sterilization and Disinfection. Types and Applications Dry Heat, Steam under pressure, Gases, Radiation and Filtration Chemical Agents and their Mode of	15 lectures	30 hrs



	<p>Action - Aldehydes, Halogens, Quaternary Ammonium Compounds, Phenol and Phenolic Compounds, Heavy Metals, Alcohol, Dyes, and Detergents</p> <p>Ideal Disinfectant. Examples of Disinfectants and Evaluation of Disinfectant</p>		
<p><b>Unit III</b> <b>Nutrition, Cultivation and Enumeration of Microorganisms</b></p>	<p><b>Nutrition and Cultivation of Microorganisms</b> Nutritional Requirements : Carbon, Oxygen, Hydrogen, Nitrogen, Phosphorus, Sulphur and Growth Factors. Classification of Different Nutritional Types of Organisms. Design and Types of Culture Media. Simple Medium, Differential, Selective and Enrichment Media Concept of Isolation and Methods of Isolation. Pure Culture Techniques <b>Growth and Enumeration</b> Growth Phases, Growth Curve. Arithmetic 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</p>	15 lectures	30 hrs

## SEMESTER I

### Biotechnology I : Introduction to Biotechnology

COURSE CODE	TITLE	CREDITS	Notional Hours
<b>USBT 105</b>	<b>Introduction to Biotechnology</b>	<b>2</b>	
<b>Unit I Scope and Introduction to Biotechnology</b>	History and Introduction to Biotechnology What is Biotechnology? Definition of Biotechnology, Traditional and Modern Biotechnology, Branches of Biotechnology- Plant, Animal Biotechnology, Marine Biotechnology, Agriculture, Healthcare, Industrial Biotechnology, Pharmaceutical Biotechnology, Environmental Biotechnology. Biotechnology Research in India. Biotechnology Institutions in India (Public and Private Sector) Biotech Success Stories Biotech Policy Initiatives Biotechnology in context of Developing World Public Perception of Biotechnology	15 lectures	30 hrs
<b>Unit II Applications Biotechnology</b>	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
<b>Unit III Food and Fermentation Biotechnology</b>	<b>Food Biotechnology</b> Biotechnological applications in 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 A	15 lectures	30 hrs

	spect in Food Industries Biotechnology and Food - Social Appraisal <b>Fermentation Technology</b> Defination, Applications of Fermentation Technology Microbial Fermentations Overview of Industrial Production of Chemicals (Acetic Acid, Citric Acid and Ethanol), Antibiotics, Enzymes and Beverages		
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## SEMESTER - I

### Biotechnology II : Molecular Biology

COURSE CODE	TITLE	CREDITS	Notional Hours
<b>USBT 106</b>	<b>Molecular Biology</b>	<b>2</b>	
<b>Unit I Replication</b>	DNA Replication in Prokaryotes and Eukaryotes- Semi-conservative DNA replication, DNA Polymerases and its role, E.coli Chromosome Replication, Bidirectional Replication of Circular DNA molecules. Rolling Circle Replication, DNA Replication in Eukaryotes DNA Recombination – Holliday Model for Recombination Transformation	15 lectures	30 hrs
<b>Unit II Mutation and DNA Repair</b>	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
<b>Unit III Genetic Engineering</b>	Experimental evidences for DNA and RNA as Genetic Material. Genetic Engineering in E coli and other Prokaryotes, Yeast, Fungi and Mammalian Cells Cloning Vectors - Plasmids ( pBR 322, pUC)	15 lectures	30 hrs

	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		
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**Semester – I**  
**Practicals**

**SEMESTER – I**  
**Practicals**  
**Basic Chemistry**

<b>COURSE CODE</b>	<b>TITLE</b>	<b>CREDITS</b>	<b>Notional Hours</b>
<b>USBTP 101</b>	<b>Basic Chemistry</b>	<b>2</b>	<b>30 hrs</b>
<ol style="list-style-type: none"> <li>1. Safety Measures and Practices in Chemistry Laboratory, Working and use of a Digital Balance, Functioning and Standardization of <i>pH</i> Meter, Optical Activity of a Chemical Compounds by Polarimeter</li> <li>2. Preparation of Standard (Molar, Molal and Normal solutions) and Buffer Solutions Determination of strength of HCl in commercial sample</li> <li>3. Qualitative Analysis of Inorganic Compounds - Three experiments</li> <li>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</li> <li>5. To Standardize commercial sample of NaOH using KHP (Potassium hydrogen phthalate) and sample of HCl using borax.</li> <li>6. Dissociation Constant of Weak Acids by Incomplete Titration Method using <i>pH</i> Meter and determination of Acetic acid in Vinegar by Titrimetric Method</li> <li>7. Determination of the amount of Fe (II) present in the given solution Titrimetrically</li> <li>8. Determination of amount of NaHCO<sub>3</sub> + Na<sub>2</sub>CO<sub>3</sub> in the given solid mixture Titrimetrically</li> <li>9. Determination of the amount of Mg (II) present in the given solution complexometrically</li> <li>10. Determination of percent composition of BaSO<sub>4</sub> and NH<sub>4</sub>Cl in the given mixture Gravimetrically</li> <li>11. Separation of Cu, Ni and Fe using Paper Chromatography and amino acids - paper chromatography</li> <li>12. Determination of fluoride ion using Colorimetry and Fe (III) by using Salicylic Acid by Colorimetric Titration</li> </ol>			

**SEMESTER – I**  
**Practicals**  
**Basic Life Science**

<b>COURSE CODE</b>	<b>TITLE</b>	<b>CREDITS</b>	<b>Notional Hours</b>
<b>USBTP 102</b>	<b>Basic Life Science</b>	<b>2</b>	<b>30 hrs</b>
<ol style="list-style-type: none"> <li>1. Components and working of Simple, Compound, Dark Field, Fluorescent and Phase Contrast Microscope</li> <li>2. Staining of Plant and Animal Tissues using Single and Double Staining Techniques</li> <li>3. Special Staining Technique for Cell Wall, Capsule and Endospores and Fungal Staining</li> <li>4. Monochrome Staining, Differential Staining, Gram Staining, and Acid Fast Staining and Romanowsky Staining</li> <li>5. Study of Plant, Animal and Microbial Groups with at least one examples from each x 3</li> <li>6. Study of Photomicrographs of Cell Organelles</li> <li>7. Sterilization of Laboratory Glassware and Media using Autoclave</li> <li>8. Preparation of Media- Nutrient broth and Agar, MacConkey Agar, Sabourauds Agar</li> <li>9. Isolation of Organisms : T-streak, Polygon method</li> <li>10. Enumeration of microorganisms by Serial Dilution, Pour Plate, Spread Plate Method</li> </ol>			

- 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
<b>USBTP 103</b>	<b>Basic Biotechnology</b>	<b>2</b>	<b>30 hrs</b>
<ol style="list-style-type: none"> <li>1. Assignment- Study of any branch of biotechnology and its applications</li> <li>2. Microbial examination of food and detection of Pathogenic Bacteria from Food Samples</li> <li>3. Isolation of organisms causing Food Spoilage</li> <li>4. Microscopic determination of Microbial flora from Yoghurt and Lactic Acid Determination</li> <li>5. Analysis of Milk- Methylene Blue, Resazurin Test, Phosphatase Test</li> <li>6. Extraction of Caesin from Milk</li> <li>7. Meat Tenderization using Papain</li> <li>8. Fermentative production of <b>Alcohol</b></li> <li>9. Determination of Alcohol content</li> <li>10. Isolation and purification of DNA (genomic, plasmid)</li> <li>11. Restriction Digestion</li> <li>12. Agarose Gel Electrophoresis of the genomic and plasmid DNA</li> </ol>			

**SEMESTER – II**  
**THEORY**



## SEMESTER II

### Chemistry II : Bioorganic Chemistry

COURSE CODE	TITLE	CREDITS	Notional Hours
<b>USBT 201</b>	<b>Bioorganic Chemistry</b>	<b>2</b>	
<b>Unit I Biomolecules: Carbohydrates and Lipids</b>	<p><b>Carbohydrates:</b> Structure, Function, Classification, Characteristic Reactions, Physical and Chemical Properties, D &amp; 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,</p> <p><b>Lipids:</b> Classification of Lipids, Properties of Saturated, Unsaturated Fatty Acids, Rancidity, and Hydrogenation of Oils</p> <p>Phospholipids: Lecithin Cephalin, Plasmalogen</p> <p>Triacylglycerol-Structure and Function</p> <p>Sterols: Cholesterol: Structure and Function, Lipoproteins: Structure and Function, Storage Lipids, Structural Lipids, Action of Phospholipases, Steroids</p>	15 lectures	30 hrs
<b>Unit II Biomolecules: Proteins and Amino Acids</b>	<p><b>Proteins and Amino Acids:</b> Classification, Preparation and Properties, Isoelectric Point, Peptide Synthesis</p> <p>Proteins: Classification based on Structure and Functions, Primary Structure, N-terminal (Sanger and Edmans Method) and C-terminal Analysis (Enzyme) Reactions of Amino Acids, Sorenson's Titration, Ninhydrin Test.</p> <p>Denaturation of protein Structure of Peptides.</p> <p>Titration Curve of Amino Acids.</p> <p>Concept of Isoelectric pH, Zwitter ion.</p> <p>Glycoproteins</p>	15 lectures	30 hrs
<b>Unit III Biomolecules: Nucleic Acids</b>	<p><b>Nucleic Acids:</b> Structure, Function of Nucleic Acids, Properties and Types of DNA, RNA. Structure of Purine and Pyrimidine Bases Hydrogen Bonding between Nitrogenous Bases in DNA</p>	15 lectures	30 hrs

	Differences between DNA and RNA, Structure of Nucleosides, Nucleotides and Polynucleotides.		
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## SEMESTER II

### Chemistry II : Physical Chemistry

COURSE CODE	TITLE	CREDITS	Notional Hours
<b>USBT 202</b>	<b>Physical Chemistry</b>	<b>2</b>	
<b>Unit I Thermodynamics</b>	<p><b>Thermodynamics:</b> 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.</p>	15 lectures	30 hrs
<b>Unit II Chemical Kinetics</b>	<p><b>Reaction Kinetics:</b> Rate of Reaction, Rate Constant, Measurement of Reaction Rates Order &amp; 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).</p>	15 lectures	30 hrs
<b>Unit III Oxidation Reduction reactions</b>	<p><b>Principals of Oxidation &amp; Reduction Reactions –</b> Oxidising and Reducing Agents, Oxidation Number, Rules to assign Oxidation Numbers with examples Ions like Oxalate, Permanganate and Dichromate. Balancing Redox Reactions by Ion Electron Method Oxidation, Reduction, Addition and Substitution and Elimination Reactions.</p>	15 lectures	30 hrs

## SEMESTER II

### Basic Life Science I : Physiology and Ecology

COURSE CODE	TITLE	CREDITS	Notional Hours
<b>USBT 203</b>	<b>Physiology and Ecology</b>	<b>2</b>	
<b>Unit I Plant Physiology</b>	<p>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</p> <p>Plant hormones - Auxin ,Gibbrellins, Cytokinins, Ethylene, Abscissic acid Introduction to Secondary Metabolites</p>	15 lectures	30 hrs
<b>Unit II Animal Physiology</b>	<p>Physiology of Digestion</p> <p>Movement of Food and Absorption, Secretary functions of Alimentary Canal, Digestion and Absorption, assimilation in Gut of Mammals</p> <p>Anatomy of Mammalian Kidney, Structure of Nephron, Physiology of Urine Formation and Role of Kidney in Excretion and Osmoregulation</p> <p>Physiology of Respiration, Mechanism of Respiration Principles of Gaseous Exchange in the Blood and Body Fluids</p> <p>Blood and Circulation : Blood Composition, Structure and Function of its Constituents Blood Coagulation and Anti-Coagulants Hemoglobin and its Polymorphism Regulation of the Circulation Mechanism and working of Heart in Human.</p>	15 lectures	30 hrs
<b>Unit III</b>	Ecology and Biogeography. Ecosystems, Definition and Compone	15 lectures	30 hrs

<b>Ecosystem and Interactions</b>	<p>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.</p>		
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## SEMESTER – II

### Basic Life II : Genetics

<b>COURSE CODE</b>	<b>TITLE</b>	<b>CREDITS</b>	<b>Notional Hours</b>
<b>USBT 204</b>	<b>Genetics</b>	<b>2</b>	
<b>Unit I Genetics Fundamentals</b>	<p>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 and Phenotype. Environmental effect on the expression of the Human Genes. Gene Interaction. Epistasis.</p>	15 lectures	30 hrs
<b>Unit II Microbial Genetics</b>	<p>Genetic analysis in Bacteria- Prototrophs, Auxotrophs. Bacteriophages: Lytic and Lysogenic Development of Phage. Mechanism of Genetic Exchange in Bacteria: Conjugation; Transformation; Transduction; (Generalized Transduction, Sp</p>	15 lectures	30 hrs

	<p>pecialized Transduction)  Bacterial Transposable Elements.</p>		
<p><b>Unit III</b>  <b>Population Genetics</b></p>	<p>Genetic Structure of Populations – Ge  notypic Frequencies and Allelic Frequ  encies,  Hardy- Weinberg Law and its assumpt  ions  Genetic Variations in Populations- Me  asuring Genetic Variation at Protein L  evel and measuring Genetic Variations  at DNA level  Natural Selection.  Genetic Drift  Speciation  Role of Population Genetics in Conse  vation Biology</p>	15 lectures	30 hrs

## SEMESTER II

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

COURSE CODE	TITLE	CREDITS	Notional Hours
<b>USBT 205</b>	<b>Tissue Culture &amp; Scientific Writing and Communication Skills</b>	<b>2</b>	
<b>Unit I Plant Tissue Culture</b>	<p>Cell Theory, Concept of Cell Culture, Cellular Totipotency, Organization of Plant Tissue Culture Laboratory :</p> <p>Equipments and Instruments Aseptic Techniques: Washing of Glassware, Media Sterilization, Aseptic Workstation, Precautions to maintain Aseptic Conditions.</p> <p>Culture Medium: Nutritional requirements of the explants, PGR's and their <i>in-vitro</i> roles, Media Preparation Callus Culture Technique: Introduction, Principle and Protocols</p>	15 lectures	30 hrs
<b>Unit II Animal Tissue Culture</b>	<p><b>Basics of Animal Tissue Culture</b> 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</p>	15 lectures	30 hrs
<b>Unit III Scientific Writing and Communication Skills</b>	<p><b>Communication Skills</b> 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 &amp;</p>	15 lectures	30 hrs

	Presentation <b>Scientific Writing</b> 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.		
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## SEMESTER - II

### Biotechnology II : Enzymology, Immunology and Biostatistics

COURSE CODE	TITLE	CREDITS	Notional Hours
<b>USBT 206</b>	<b>Enzymology, Immunology and Biostatics</b>	<b>2</b>	
<b>Unit I Enzymes</b>	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
<b>Unit II Immunology</b>	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	15 lectures	30 hrs

	<p>(Framework region) Classes of Immunoglobulins, Antigenic Determinants.</p> <p>Antigen-Antibody Interactions</p> <p>Monoclonal Antibodies,</p> <p>Vaccines (Live, Killed) and Toxoid.</p> <p>Problems with Traditional Vaccines, Impact of Biotechnology on Vaccine Development.</p>		
<p><b>Unit III</b> <b>Biostatistics</b></p>	<p>Defination and Importance of Statistics in Biology</p> <p>Types of Data, Normal and Frequency Distribution</p> <p>Representation of Data and Graphs (Bar Diagrams, Pie Charts and Histogram, Polygon and Curve)</p> <p>Types of Population Sampling</p> <p>Measures of Central Tendency (For Raw, Ungroup &amp; Group Data)</p> <p>Mean</p> <p>Median</p> <p>Mode</p> <p>Measures of Dispersion</p> <p>Range, Variance, Coefficient of Variance.</p> <p>Standard Deviation.</p> <p>Standard Error.</p>	<p>15 lectures</p>	<p>30 hrs</p>



**Semester – II**  
**PRACTICALS**

**SEMESTER – II****Practicals  
Chemistry**

<b>COURSE CODE</b>	<b>TITLE</b>	<b>CREDITS</b>	<b>Notional Hours</b>
<b>USBTP 201</b>	<b>Chemistry</b>	<b>2</b>	<b>30 hrs</b>
<ol style="list-style-type: none"> <li>1. Spot test for Carbohydrates, Fats and Proteins and Amino Acids and Nucleic Acids</li> <li>2. Standardization of Colorimeter and Estimation of Reducing sugar by DNSA method</li> <li>3. Estimation of Protein by Biuret method and Lowry method</li> <li>4. Saponification of Fats, Saponification Value of Oil or Fat, Iodine value of Oil and determine the rate constant for the saponification reaction between ethyl acetate and NaOH by back titration method</li> <li>5. To determine enthalpy of dissolution of salt like KNO<sub>3</sub></li> <li>6. Determine the rate constant for hydrolysis of ester using HCl as a catalyst</li> <li>7. Study the kinetics of reaction between Thiosulphate ion and HCl</li> <li>8. Study reaction between potassium Persulphate and Potassium Iodide kinetically and hence to determine order of reaction</li> <li>9. Study the reaction between NaHSO<sub>3</sub> and KMnO<sub>4</sub> and balancing the reaction in acidic, alkaline and neutral medium</li> <li>10. Study transfer of electrons (Titration of sodium thiosulphate with potassium dichromate)</li> <li>11. Determination of the volume strength of hydrogen peroxide solution by titration with standardised potassium permanganate solution</li> <li>12. Determination of amount of K oxalate and oxalic acid in the given solution Titrimetrically</li> </ol>			

**SEMESTER – II****Practicals  
Life Science**

<b>COURSE CODE</b>	<b>TITLE</b>	<b>CREDITS</b>	<b>Notional Hours</b>
<b>USBTP 202</b>	<b>Life Science</b>	<b>2</b>	<b>30 hrs</b>
<ol style="list-style-type: none"> <li>1. Study of Hill's reaction</li> <li>2. Colorimetric study of Absorption Spectrum of Photosynthetic Pigments</li> <li>3. <b>Movemnt of Food in Paramecium</b></li> <li>4. Activity of Salivary Amylase on Starch</li> <li>5. Analysis of Urine</li> <li>6. Study of Mammalian Blood, Blood count using Haemocytometer and estimation of Haemoglobin in Mammalian Blood</li> <li>7. Study of Human Blood Groups</li> <li>8. Study of Mammalian Kidney and Heart</li> <li>9. Problems in Mendelian Genetics</li> <li>10. Study of Mitosis and Meiosis</li> <li>11. Study of Karyotypes – Normal Male and Normal Female</li> <li>12. Study of Interactions Commensalism, Mutualism, Predation and Antibiosis, Parasitism.</li> </ol>			

**SEMESTER – II**  
**Practicals**  
**Biotechnology**

COURSE CODE	TITLE	CREDITS	Notional Hours
<b>USBTP 203</b>	<b>Biotechnology</b>	<b>2</b>	<b>30 hrs</b>
<ol style="list-style-type: none"> <li>1. Working and use of various Instruments used in Biotechnology Laboratory (Autoclave, Hot air Oven, Centrifuge, Incubator, Rotary Shaker, Filter Assembly, LAF, <i>pH</i> meter and Colorimeter)</li> <li>2. Laboratory Organization and Layout for Plant and Animal Tissue Culture Laboratory</li> <li>3. Preparation of Stock Solutions and Preparation of Media for PTC</li> <li>4. Aseptic Transfer Technique, Surface Sterilization and Inoculation for Callus Culture</li> <li>5. Media Preparation and Sterilization (ATC)</li> <li>6. Trypsinization of Tissue and Viability Count</li> <li>7. Qualitative Assay of Enzyme Amylase. Lipase, Protease, Urease, Catalase and Dehydrogenase</li> <li>8. Enzyme Kinetics : Study of the effect of <i>pH</i>, Temperature on activity of Enzyme</li> <li>9. Study of Effect of Substrate Concentration on enzyme activity and determination of Vmax and Km</li> <li>10. Study of antigen antibody interaction by Ouchterlony method</li> <li>11. Biometric Analysis for Mean, Median, Mode and Standard Deviation and Data representation using frequency Polygon, Histogram and Pie Diagram</li> <li>12. Preparation of review reports of 5 Scientific Papers and Presentation (last 5 years)</li> </ol>			

## **Scheme of Examination:**

The performance of the learners shall be evaluated into two parts.

The learner's performance shall be assessed by Internal Assessment with 40% marks in the first part & by conducting the Semester End Examinations with 60% marks in the second part.

The Course having Practical training will have Practical Examination for 50 marks at the end of Semester, out of which 30 marks for the Practical task assigned at the time of examination. The 20 marks are allotted as Internal Assessment.

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

**Internal Assessment:** It is defined as the assessment of the learners on the basis of continuous evaluation as envisaged in the Credit based system by way of participation of learners in various academic and correlated activities in the given semester of the programme.

**Semester End Assessment :** It is defined as the assessment of the learners on the basis of Performance in the semester end Theory/ written/ Practical examination.

**Modality of Assessment : Internal Assessment - 40%**

**a) Theory**

**40 marks. 40marks**

Sr No	Evaluation type	Marks
1	Two Assignments/Case study/Project	20
2	One class Test (multiple choice questions objective)	10
3	Active participation in routine class instructional deliveries(case studies/ seminars//presentation)	05

4	Overall conduct as a responsible student, manners, skill in articulation, leadership qualities demonstrated through organizing co-curricular activities, etc.	05
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### **b) Practicals**

### **B) External examination - 60 %**

### **Semester End Theory Assessment - 60%**

### **20 marks 60 marks**

Sr No	Evaluation type	Marks
1	Two best Practicals	10
2	Journal	05
3	Viva	05

1. Duration - These examinations shall be of two hours duration.
2. Theory question paper pattern :-
  1. There shall be four questions each of 15 marks. On each unit there will be one question & fourth one will be based on entire syllabus.
  2. All questions shall be compulsory with internal choice within the questions. Each question will be of 20 to 23 marks with options.
  3. Questions may be sub divided into sub questions a, b, c, d & e only & the allocation of marks depends on the weightage of the topic.

### **Practical External Assessment 30 marks**