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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

Preamble:

Twenty First Century is known as the Century of Biotechnology. Biotechnology is one of the youngest branches of Life Science, which has 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 a unique status for Biotechnology in Research and Industry.

The socio-economic potential of Biotechnology is well established which has almost become synonymous with modern 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 is fast 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 are revised 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 revised syllabus combines basic principles 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.

Dr. Anuradha Majumdar (Dean, Science and Technology)

Dr. Shivram Garje (Associate Dean, Science)

Dr. Archana Rath (Chairperson, Ad Hoc BOS in Biotechnology)

Dr. Tara Menon (Member)

Dr. Deepali Karkhanis (Member)

Dr. Sneha Panvalkar (Member)

Dr. Seema Kokitkar (Member)

Dr. Jayaprada R. Chunduri (Member)

Dr. Bhupendra Pushkar (Member)

Dr. Rajesh C. Patil (Member)

Dr. Varsha K. Mane (Member)

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

Course code	Course Type	Title	Credits	Nos of Lectures /week
USBT101	Core Subject	Fundamentals of biotechnology-I	2	3
USBT102	Core Subject	Microbiology-I	2	3
USBT103	Core Subject	Basic Chemistry-I	2	3
USBT104	Core Subject	Biochemistry: Concept of Biomolecules-I	2	3
USBT105	Core Subject	Genetics	2	3
USBT106	Core Subject	Molecular biology-I	2	3
USBT107	Ability enhancement course	Ability enhancement course - Communication skills	2	3
USBTTP101	Core Subject practicals	Practicals of USBT101 & USBT102	2	3
USBTTP102	Core Subject practicals	Practicals of USBT103 & USBT104	2	3
USBTTP103	Core Subject practicals	Practicals of USBT105 & USBT106	2	3
	TOTAL		20	

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
USBTTP101	Core Subject practicals	Practicals of USBT201 & USBT202	2	3
USBTTP102	Core Subject practicals	Practicals of USBT203 & USBT204	2	3
USBTTP103	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	
<p>Course Objectives: To familiarize the students with the potential and different applications of biotechnology</p> <p>Learning Outcomes: By the end of the course the student will:</p> <ul style="list-style-type: none"> • 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	<p>What is biotechnology? Biotechnology –an interdisciplinary biological science; Biotechnology – definition; History & Introduction to Biotechnology; Traditional and Modern Biotechnology; Scope and importance of biotechnology;</p> <p>World of Biotechnology- Pharmaceutical Biotechnology, Plant Biotechnology, Industrial Biotechnology, Marine Biotechnology, Animal Biotechnology, Medical biotechnology, Environmental Biotechnology.</p> <p>Biotechnology in India – Bio-business in India, booming biotech market, success story of biotech market, policy initiatives; and global trends; Biotechnology research in India;</p> <p>Potential of modern biotechnology; Achievement of biotechnology; Prevention of misuse of biotechnology; Biotechnology Institutions in India (Public and Private Sector); Public Perception of Biotechnology.</p> <p>Case study: Serum Institute of India and its products</p>		15
Unit II- Applications of biotechnology	<p>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</p>		15

	<p>Human welfare: Cloned genes for production of -Insulin; recombinant vaccine for Hepatitis B virus. Molecular farming, Edible vaccines and their advantages</p> <p>Environment- Pollution abatement through GMOs</p> <p>Bioethics Case study: Genetically modified microbes for bioremediation of oil spills in marine environment</p>		
<p>Unit III- Fermentation technology</p>	<p>Introduction to fermentation processes: Microbial biomass, Microbial enzymes, Microbial metabolites, recombinant products, transformation processes. Development of fermentation Industry</p> <p>Component parts of fermentation process</p> <p>Screening: Definition, Primary screening and its methods, Secondary screening and its methods</p> <p>Fermenter design: Definition of a fermenter, aerated stirred tank batch fermenter-Typical design, Construction materials used, aeration and agitation</p> <p>Basic introduction to process parameters: Temperature control, Foam production and control pH measurement and control, CO₂ and O₂ control</p> <p>Fermentation medium: Basic requirements of industrial media, Criteria for use of raw materials in media, Examples of raw materials used, Growth factors, Water, Carbohydrate sources, Protein sources</p> <p>Product: A typical process of Ethanol production and Antibiotic production</p>		15
<p>References</p>	<ol style="list-style-type: none"> 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	
<p>Course Objectives: To build firm foundation in microbiology, sterilization techniques and staining.</p> <p>Learning Outcomes: By the end of the course the student will:</p> <ul style="list-style-type: none"> • 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	<p>Fundamentals, History and Evolution of Microbiology: Discovery of Microorganisms, Conflict over spontaneous generation. Role of microorganisms in disease</p> <p>Classification: The place of Microorganisms in the living world, Classification Whittaker's five kingdom classification, Introduction to Bergey's Manual, Groups of Microorganisms, Applications of microbiology in various fields</p> <p>Nutrition, Cultivation and Maintenance of microorganisms: Nutritional categories of microorganisms, Design and Types of Culture Media, methods of isolation.</p>		15
Unit II- Sterilization techniques	<p>Introduction: Definition and concept of Sterilization and Disinfection.</p> <p>Types and Applications: Dry Heat, Steam under pressure Gases, Radiation and Filtration</p> <p>Chemical Agents and their Mode of Action: Aldehydes, Halogens, Quaternary Ammonium Compounds, Phenol and Phenolic Compounds, Heavy Metals, Alcohol, Dyes, and Detergents.</p> <p>Disinfectant: Ideal Disinfectant. Examples of Disinfectants and Evaluation of Disinfectant</p>		15
Unit III- Microscopy and stains	<p>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.</p> <p>Dark Field Microscope; Phase Contrast Microscope and Fluorescent Microscope, TEM, SEM</p> <p>Applications of microscopes</p> <p>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.</p>		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	
<p>Course Objectives: To acquaint the students with basic concepts of Chemistry like nomenclature, chemical bonds, titrimetric, gravimetry, stereochemistry etc.</p> <p>Learning Outcomes: By the end of the course the student will:</p> <ul style="list-style-type: none"> • 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	<p>Classification and Systematic Nomenclature of organic compounds (few examples)</p> <p>Chemical Bonds: Types and transition between the main types of bonding.</p> <p>Ionic Bond: Nature of Ionic Bond, factors influencing the formation of Ionic Bond. Structure of NaCl and CsCl.</p> <p>Covalent Bond: Nature of Covalent Bond, Types of covalent bond (Polar and Coordinate covalent bonds). Structure of CH₄, NH₃, H₂O, Shapes of BeCl₂, BF₃.</p> <p>Hydrogen Bond: Theory of Hydrogen Bonding and Types of Hydrogen Bonding (with examples of RCOOH, ROH, Salicylaldehyde, Amides and Polyamides).</p>		15

<p>Unit II- Titrimetric and gravimetry</p>	<p>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.</p> <p>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.</p>		<p>15</p>
<p>Unit III- Stereochemistry</p>	<p>Isomerism: Types of Isomerism: Constitutional Isomerism (Chain, Position and Functional) and Stereoisomerism, Chirality.</p> <p>Geometric Isomerism and Optical Isomerism: Enantiomers, Diastereomers, and Racemic mixtures Cis-Trans, Threo, Erythro and Meso isomers. Diastereomerism (Cis-Trans Isomerism) in Alkenes and Cycloalkanes (3 and 4 membered ring)</p> <p>Conformation: Conformations of Ethane. Difference between Configuration and Conformation.</p> <p>Configuration: Asymmetric Carbon Atom, Stereogenic/ Chiral Centers, Chirality Representation of Configuration by —Flying Wedge Formula</p> <p>Projection formulae: Fischer, Newman and Sawhorse. The Interconversion of the Formulae.</p>		<p>15</p>
<p>References</p>	<ol style="list-style-type: none"> 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	
<p>Course Objectives: To acquaint the students with different concepts of biomolecules</p> <p>Learning Outcomes: By the end of the course the student will:</p> <ul style="list-style-type: none"> Develop skills towards preparation of standard solutions in the laboratory. Understand the role of buffers Discuss the basics of carbohydrate and lipid biochemistry. 			
<p>Unit I- Water, Standard solutions and Buffers</p>	<p>Structure, Properties and functions: Water</p> <p>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.</p> <p>Concept of pH: Buffer solutions –Concept of Buffers, Derivation of Henderson -Hasselbach equation for Acidic and Basic buffers. Buffering capacity</p> <p>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)</p>		15
<p>Unit II- Basics of Carbohydrate Chemistry</p>	<p>Carbohydrates: Introduction, definition and general formula.</p> <p>Classification of carbohydrates:</p> <p>Monosaccharides: Two Families of Monosaccharides. Aldo series and keto series; (Triose - Glyceraldehyde and Dihydroxyacetone, Tetrose- Erythrose and Erythrulose, Pentose- Xylose, Xylulose, Ribose, Ribulose, Hexose- Glucose, Galactose, Mannose, Heptose- sedoheptose and Sedoheptulose (structures to be taught) Concept of Enantiomers, Mutarotation, Anomeric carbon and Epimers of glucose.</p> <p>Biologically important Derivatives of Hexoses: Glucosamine, Gluconic acid, uronic acid, NAGA, NAMA</p> <p>Chemical reactions of monosaccharides</p> <p>Concept of glycosidic bond.</p> <p>Disaccharides: Maltose, Lactose, Sucrose, Cellobiose (structures to be taught, biological significance, structure and bond type)</p> <p>Polysaccharides: Homopolysaccharides and Heteropolysaccharides; Structural</p>		15

	<p>and Storage Polysaccharides. E.g., of polysaccharides -: starch (amylose and amylopectin), Glycogen, Peptidoglycan, Cellulose, chitin (structure and bond type)</p> <p>Examples of Reducing and nonreducing carbohydrates.</p> <p>Industrial applications of carbohydrates: Fermentation, Pharmaceutical and Food industry.</p>		
<p>Unit III- Basics of Lipid Chemistry</p>	<p>Introduction to Lipid Chemistry: Definition and Biological functions of fats and Lipids. Definition of Fatty acids. Classification of Fatty acids: Saturated Fatty Acids: C2- C20 (Examples with trivial name, Biochemical names and Structures) Unsaturated Fatty Acids: Definition of MUFA and PUFA. C16- C20. Palmitic, 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</p>		15
<p>References</p>	<ol style="list-style-type: none"> 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	
<p>Course Objectives: To provide insight to students on fundamental concepts of mendelian genetics, microbial genetics and population genetics</p> <p>Learning Outcomes: By the end of the course the student will:</p>			

<ul style="list-style-type: none"> • 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 <i>E.coli</i> . The sex factor F, High-Frequency Recombination Strains of <i>E.coli</i> . 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,		

	<p>Evolution and Ecology: Evolution and Ecology. S. Chand Publishing.</p> <p>3. Simmons, M. J., & Snustad, D. P. (2006). Principles of genetics. John Wiley & Sons.</p> <p>4. Russell, P. J. (2000). Fundamentals of genetics. Longman Publishing Group.</p> <p>5. Karp, G. (2009). Cell and molecular biology: concepts and experiments. John Wiley & Sons.</p> <p>6. Strickberger M., Genetics. (1995). Australia: Deakin University.</p>
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Course Code	Title	Credits	No of lectures
USBT106	Molecular biology-I	02	
<p>Course Objectives: To build a firm foundation of molecular biology</p> <p>Learning Outcomes: By the end of the course the student will:</p> <ul style="list-style-type: none"> • 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	<p>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.</p> <p>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</p> <p>Chromosome Banding Techniques. Karyotype and Idiogram</p>		15
Unit II- DNA replication	<p>Models of DNA Replication Evidence of Semi-conservative DNA replication- Messelhsen and Stahl’s experiment DNA Polymerases and its role,</p> <p>DNA Replication in Prokaryotes: <i>E.coli</i> Chromosome Replication, Semi-discontinuous replication Bidirectional Replication of Circular DNA molecules. Rolling Circle Replication,</p>		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	<ol style="list-style-type: none"> 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	
<p>Course Objectives: To acquaint the students with different aspects of communication skills.</p> <p>Learning Outcomes: By the end of the course the student will:</p> <ul style="list-style-type: none"> • 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	<p>Essentials of Grammar: Parts of speech, Articles, Modals, Sentences and their types., Punctuation marks</p> <p>Employment Communication: Introduction, Resume, Curriculum Vitae, Scannable Resume, Developing an Impressive Resume, Formats of Resume, Job Application or Cover Letter. Email Writing</p> <p>Professional Presentation: Nature of Oral Presentation, planning a Presentation, Preparing the Presentation, Delivering the Presentation</p>		15

	<p>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</p> <p>Group Discussion: Introduction, Ambience/Seating Arrangement for Group Discussion, Importance of Group Discussions, Difference between Group Discussion, Panel Discussion and Debate, Traits, Types of Group Discussions, topic based and Case based Group Discussion, Individual Traits</p>		
<p>Unit II- Soft skills</p>	<p>Introduction to Soft Skills and Hard Skills</p> <p>Personality Development: Knowing Yourself, Positive Thinking, Johari's Window, Communication Skills, Non-verbal Communication, Physical Fitness</p> <p>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</p> <p>Etiquette and Mannerism: Introduction, Professional Etiquette, Technology Etiquette</p> <p>Communication Today: Significance of Communication, GSC's 3M Model of Communication, Vitality of the Communication Process, Virtues of Listening, Fundamentals of Good Listening, Nature of Non-Verbal Communication, Need for Intercultural Communication, Communicating Digital World</p>		15
<p>Unit III- Professional skills</p>	<p>Creativity at Workplace: Introduction, Current Workplaces, Creativity, Motivation, Nurturing Hobbies at Work, The Six Thinking Hat Method</p> <p>Ethical Values: Ethics and Society, Theories of Ethics, Correlation between Values and behavior, Nurturing Ethics, Importance of Work Ethics, Problems in the Absence of Work Ethics</p> <p>Capacity Building: Need and Importance of Capacity Building Elements of Capacity Building Zones of Learning Ideas for Learning Strategies for Capacity Building</p> <p>Leadership and Team Building: Leader and Leadership, Leadership Traits, Culture and Leadership, Leadership Styles and Trends, Team Building, Types of Teams</p> <p>Decision Making and Negotiation: Introduction to Decision Making, Steps for Decision Making, Decision Making Techniques, Negotiation Fundamentals, Negotiation Styles, Major Negotiation Concepts</p> <p>Stress and Time Management: Stress, Sources of Stress, Ways to Cope with Stress</p>		15
<p>References</p>	<ol style="list-style-type: none"> 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. 		

	<p>4. Guffey, M. E., & Loewy, D. (2012). Essentials of business communication. Cengage Learning.</p> <p>5. Rao, M. S. (2010). Soft skills-enhancing employability: connecting campus with corporate. IK International Pvt Ltd.</p> <p>6. Sherfield, R. M. (2009). Cornerstone: Developing Soft Skills. Pearson Education India.</p>
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Course Code	Title	Credits	Notional hours
USBTP101	Practicals of USBT101 and USBT102	2	45

<ol style="list-style-type: none"> 1. Assignment on any one branch of Biotechnology. 2. Analyse a case-study and write a report on any one recent application of Biotechnology (Not older than past 5 years) 3. Field visit/ Virtual visit (website) of National/ International research institutes for research in biotechnology and have a group discussion during the lab session. 4. Study of Microscope – Compound Microscope (Including Handling and storage), Dark Field Microscope, Phase Contrast Microscope, Fluorescent Microscope, TEM, SEM. (Including ray diagrams) 5. 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. 			
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Course Code	Title	Credits	Notional hours
USBTP102	Practicals of USBT103 and USBT104	2	45

<ol style="list-style-type: none"> 1. Safety in Chemistry Laboratory: Dress code, Dos and Don't, First Aid 			
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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 $\text{NaHCO}_3 + \text{Na}_2\text{CO}_3$ in the given solid mixture Titrimetrically.
15. Determination of the amount of Mg (II) present in the given solution complexometrically.
16. Determination of percent composition of 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
<ol style="list-style-type: none"> 1. Study of mitosis from suitable plant material 2. Study of meiosis from suitable plant material/Permanent slides/Photographs 3. Study of mitosis using pre-treated root tips of <i>Allium cepa</i> to study the effect of mutagens- chemical (colchicine/ PDB) on mitosis 4. Study the effect of UV radiation as a mutagenic agent 5. Extraction of DNA from plant material. 6. Qualitative analysis of DNA 7. Identification of types of point mutations from given DNA sequences 8. Isolation of antibiotic/ dye resistant mutants using replica plate technique. 9. Demonstration of Ames test for mutagenicity. 10. Study of Karyotype - Normal male and 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	
<p>Course Objectives: To acquaint students with the applications of biotechnology in the field of food, medicine and fermentation</p> <p>Learning Outcomes: By the end of the course the student will:</p> <ul style="list-style-type: none"> ● Develop an understanding of the 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	<p>Introduction to food biotechnology: History of microorganisms in food science and key developments, Applications of biotechnology in fermented food products.</p> <p>Introduction to Unit Operations and Processes: Basic unit operations, food processing & packaging (canning & bottling), Production of cultures</p> <p>Fermented food products: Bread, Vinegar, Sauerkraut, Single Cell Protein (SCP), Probiotics</p> <p>Food spoilage, food deterioration, food contamination and Food Adulteration</p> <p>Methods of food preservation</p> <p>Indicators of Food Microbial Quality & Safety: HACCP, FSSAI & FDA</p>		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: <i>E. coli</i> ; <i>Bacillus subtilis</i> ; <i>Saccharomyces cerevisiae</i> ; Xenopus oocytes; Mammalian fertilized egg cell Introducing vector into host: Prokaryote Eukaryote Identification of recombinant clones.		15
References	<ol style="list-style-type: none"> 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. 		

	<p>7. Nicholl, D. S. T. (2002). An Introduction to Genetic Engineering (Studies in Biology). India: Cambridge University Press.</p> <p>8. Brown, T. A. (2013). Gene Cloning and DNA Analysis: An Introduction. Germany: Wiley.</p> <p>9. Genetic Engineering: Principles and Practice. (n.d.). India: McGraw-Hill Education.</p> <p>10. A Textbook of Biotechnology by R C Dubey 4th Ed</p> <p>11. Dubey, R. C. (2014). Advanced biotechnology. S. Chand Publishing</p>
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Course Code	Title	Credits	No of lectures
USBT202	Cell biology and Microbiology-II	02	
<p>Course Objectives: To build a firm foundation of concepts related to cell biology and microbiology</p> <p>Learning Outcomes: By the end of the course the student will:</p> <ul style="list-style-type: none"> • 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 			
<p>Unit I- Ultrastructure of prokaryotic and eukaryotic cell</p>	<p>Ultrastructure of Prokaryotic Cell: Concept of Cell shape, size and arrangement Bacterial structures external to cell wall: Flagella, Pili, 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</p> <p>Ultrastructure of Eukaryotic Cell: Cell wall; Plasma membrane, Cytoplasmic Matrix, Nucleus –Nuclear Structure, nuclear envelope, nucleoplasm, Nucleolus; cytoplasmic structures – cytoplasmic inclusions, cytoplasmic organelles - Endoplasmic Reticulum; Golgi Apparatus; Mitochondria; Chloroplasts; Ribosomes; Lysosome - Endocytosis, Phagocytosis, Autophagy; Peroxisomes.</p> <p>External Cell Coverings: Cilia and Flagella</p> <p>Comparison of Prokaryotic and Eukaryotic Cells</p>		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	<ol style="list-style-type: none"> 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: <ul style="list-style-type: none"> • Develop an understanding of thermodynamics • Learn about reaction kinetics and order of reaction 			

<ul style="list-style-type: none"> Gain insight in to the details of oxidation and reduction reactions 			
Unit I- Thermodynamics	<p>Thermodynamics: System, Surrounding, Boundaries Sign Conventions, State Functions, Internal Energy and Enthalpy: Significance, examples, (Numericals expected.)</p> <p>Laws of Thermodynamics and its Limitations: Mathematical expression. Qualitative discussion of Carnot Cycle for ideal Gas and Mechanical Efficiency. Laws of Thermodynamics as applied to Biochemical Systems.</p> <p>Concept of Entropy, Entropy for Isobaric, Isochoric and Isothermal Processes.</p>		15
Unit II- Chemical Kinetics	<p>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)</p> <p>Determination of Order of Reaction: a) Integration Method b) Graphical Method c) Ostwald's Isolation Method d) Half Time Method. (Numericals expected).</p>		15
Unit III- Oxidation Reduction reactions	<p>Principles of Oxidation & Reduction Reactions: Oxidising and Reducing Agents Oxidation Number, Rules to assign Oxidation Numbers with examples Ions like Oxalate, Permanganate and Dichromate.</p> <p>Balancing Redox Reactions: Ion Electron Method Oxidation, Reduction, Addition and Substitution & Elimination Reactions.</p>		15
References	<ol style="list-style-type: none"> Rao, C. N. R. (1973). University General Chemistry : An Introduction To Chemical Science. India: Macmillan India Limited. Chang, R. (2000). Physical Chemistry for the Chemical and Biological Sciences. United Kingdom: University Science Books. Lee, J.D., Concise Inorganic Chemistry, 5TH ED. (2008). India: Wiley India Pvt. Limited. Bajpai, D. N. (2001). Advanced Physical Chemistry. India: S. Chand, Limited. 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
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USBT204	Biochemistry: Concept of Biomolecules-II and Basic analytical techniques	02	
<p>Course Objectives: To build a firm foundation on the fundamentals of biochemistry and analytical techniques</p> <p>Learning Outcomes: By the end of the course the student will:</p> <ul style="list-style-type: none"> • 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	<p>Amino acids: General introduction, Classification and structures, properties (physical & chemical) Amino Acids as drugs. Titration Curve of Amino Acids. Concept of Isoelectric pH, Zwitterion</p> <p>Reactions of Amino Acids: Sorenson's Titration, Ninhydrin Test</p> <p>Proteins: Introduction, definition and functional classification.</p> <p>Classification of Proteins: Simple- Fibrous and Globular Conjugated- Nucleoprotein, Lipoprotein, Glycoprotein, Phosphoprotein, Chromoprotein, Metalloprotein Derived- Primary and Secondary</p> <p>Peptide bond: Features Example of Dipeptide, tripeptide, Nonapeptide e.g., Oxytocin, Vasopressin Amino acid composition of Bovine Cytochrome C and Bovine Chymotrypsinogen</p> <p>Three-dimensional Structure of proteins: Concept of Monomeric, dimeric and multimeric proteins Primary structure - Peptide linkage, Native Secondary structure - Alpha Pleat and Beta fold; Spatial arrangements of adjacent amino acid residues Tertiary structure - Three-Dimensional arrangement Quaternary structure Di and Multimeric proteins E.g., structure of human Insulin</p> <p>Properties of proteins: Solubility, Molecular weight, Shape, Iso electric pH, Salting out of proteins for purification</p> <p>Protein Denaturation and folding: Denaturing agents and properties of denatured proteins</p>		15
Unit II- Enzymes	<p>Introduction to biocatalysis: Properties of Enzymes Substrate, Optimum conditions, Co-substrate, Coenzyme, Cofactors</p> <p>Classification and Nomenclature (one reaction per</p>		15

		<p>class)</p> <p>Mechanism of Enzyme Action, Active Sites, Enzyme Specificity,</p> <p>Factors affecting enzyme activity (Effect of pH, Temperature, Substrate Concentration, Enzyme concentration)</p> <p>Enzyme Kinetics: Derivation of Michaelis-Menten Equation, Lineweaver-Burk plot, Concept of k_m</p> <p>Types of Enzyme Inhibitions: Irreversible & Reversible (Competitive, Uncompetitive, Non-Competitive)</p> <p>Isoenzymes (LDH, Alkaline Phosphatase, Creatine Phosphokinase)</p> <p>Allosteric Modulators, Co-Factors, Zymogens, Enzyme units</p> <p>Enzymes as Biomarkers and diagnostic tools. (SGPT, SGOT, LDH, CPK)</p> <p>Industrial Applications of Enzymes</p>		
Unit Basics of Analytical techniques	III- of	<p>Methods of Separation: Precipitation, Filtration, Distillation and Solvent Extraction</p> <p>Analytical Techniques</p> <p>Chromatography: Definition, Principles, Chromatographic performance parameters, Types Paper Chromatography, Thin Layer Chromatography, Column Chromatography (Principle and Applications)</p> <p>Spectroscopy - Colorimetry: Properties of electromagnetic radiation, interaction with matter, lasers Colorimetric assays - Principle, Beer-Lambert's Law, Measurement of Extinction, Derivation of $E = kcl$, Limitations of Beer-Lambert's Law, Filter Selection Examples of colorimetric and UV absorption assays</p> <p>Electrophoresis: General principles, Factors affecting electrophoresis, Types of support media used, Types of electrophoresis (Agarose gel electrophoresis, PAGE)</p>		15
References		<ol style="list-style-type: none"> 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	
<p>Course Objectives: To provide an insight in to the different physiological processes of plants and animals.</p> <p>Learning Outcomes By the end of the course the student will:</p> <ul style="list-style-type: none"> ● 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	<p>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</p> <p>Plant hormones: Auxin, Gibberellins, Cytokinins, Ethylene, Abscisic acid</p> <p>Introduction to Secondary Metabolites</p>		15
Unit II- Animal Physiology	<p>Introduction to physiology: Concept of homeostasis.</p> <p>Body fluids: Major types of Body fluid.</p> <p>Blood: Functions of blood, general properties of blood, Composition of blood. Thrombocytes or Platelets. Coagulation of blood. Theories of Coagulation. Haemolysis.</p> <p>Respiratory system: Phases of Respiration, Principle of gases exchange, Mechanism of breathing.</p> <p>Digestion and absorption: Mode of nutrition, Digestion: Digestion of foodstuffs, Digestion in humans. Absorption.</p> <p>Excretion: Organs of excretion. Types of excretory products. Excretion in vertebrates - Human</p> <p>Kidney: Structure of kidney, Structure of nephron. Function of kidney. Urine formation. Dialysis</p>		15

Unit III- Immunology	<p>Introduction to Immunology: Overview of Immune Systems, Innate Immunity, Mechanisms of innate immunity, Acquired Immunity, Local and Herd Immunity, Humoral and Cellular Immunity - Factors Influencing and Mechanisms of each.</p> <p>Antigens: Immunogenicity Versus Antigenicity, Factors That Influence Immunogenicity, Epitopes, Haptens, Superantigens</p> <p>Antibodies: Basic Structure of Antibodies, Antibody-Mediated Effector Functions, Antibody Classes and Biological Activities, Antigenic Determinants on Immunoglobulins.</p>		15
References	<ol style="list-style-type: none"> 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. 5. Reddy, B. (2014). Text Book of Animal Pyhysiology. Andra Paresh, IMRF Publication.. 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	
<p>Course Objectives: To develop the students' understanding of computer and biostatistics</p> <p>Learning Outcomes: By the end of the course the student will:</p> <ul style="list-style-type: none"> • 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	<p>Overview and functions of a computer system, Input and output devices, Storage devices.</p> <p>Modern computers: The workstation, The Minicomputer, Mainframe Computers, Parallel processing Computer & The Super Computer</p> <p>Introduction to operating systems: Operating System concept, Windows, Unix/Linux & servers</p> <p>Word Processing: Basic Operations, Creating and Editing documents, Formatting documents.</p> <p>Spreadsheet: Creating and editing workbook, Organizing and formatting worksheets; Data analysis and management; Using formulas and functions</p> <p>Presentation Graphics: Creating and Editing Presentations, Designing and Enhancing Presentation, Delivering Presentation, Advanced Presentation Graphics.</p>		
Unit II- Computer networking	<p>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</p> <p>Computer viruses: An overview of Computer viruses: What is a virus? Virus signs, how do they get transmitted? What are the dangers? General Precautions</p> <p>The Internet and Internet Services: Introduction, History of Internet, Internetworking Protocol, The Internet 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</p> <p>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.</p>		15
Unit III- Biostatistics	<p>Introduction to Biostatistics: Definition & Importance of Statistics in Biology Variables, Types of variables (Quantitative & Qualitative)</p> <p>Types of Data and data visualization:</p>		15

	<p>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)</p> <p>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</p> <p>Types of Statistics: Introduction to Descriptive & Inferential statistics</p> <p>Descriptive statistics: Measures of central tendency: Mean, Mode, Median (Ungrouped & Grouped data)</p> <p>Measures of dispersion: Range, Variance, Standard deviation (Ungrouped & Grouped data), Coefficient of variation</p> <p>Measures of location: Percentiles, Interquartile range (Box-Whisker plot)</p> <p>Normal/Gaussian distribution, Standard normal deviate, Sampling variation, Standard error of mean</p>		
References	<ol style="list-style-type: none"> 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	
<p>Course Objectives: To sensitize and create awareness about Ecology, renewable energy and different Environmental Issues.</p> <p>Learning Outcomes: By the end of the course the student will:</p> <ul style="list-style-type: none"> • Develop an understanding of the 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: Evolution 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.

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Course Code	Title	Credits
USBTP201	Practicals of USBT201 and USBT202	02
<p>21. Assignment - Write a report on a case study on any one food product developed at CFTRI.</p> <p>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.</p> <p>23. Microbial examination of food and detection of Pathogenic Bacteria from Food Samples</p> <p>24. Microscopic determination of Microbial flora from Yoghurt and Lactic Acid Determination</p> <p>25. Isolation and characterization of organisms causing Food Spoilage (Using Bergey's Manual)</p> <p>26. Isolation and characterization of food fermenting organism from idli batter (Using Bergey's Manual)</p> <p>27. Sauerkraut production and to analyze quality parameters during production (odour, color, pH, total acidity)</p> <p>28. Determination of food preservative concentration (salt & sugar) using MIC.</p> <p>29. Processing fruits for preparation and packaging of jams or jellies.</p> <p>30. Detection of Food adulterants in food samples</p> <p>31. Isolation of chromosomal DNA from <i>E. coli</i> and Agarose gel electrophoresis of the chromosomal DNA</p> <p>32. Study of the structure of important</p> <ol style="list-style-type: none"> animal viruses (rhabdo, influenza, paramyxo, hepatitis and retroviruses) using electron micrographs/diagrams. plant viruses (caulimo, gemini, tobacco ringspot, cucumber mosaic and alpha-alpha mosaic viruses) using electron micrographs/diagrams. (ϕX174, T4,ϕ3) using electron micrographs/diagrams. <p>33. Isolation and enumeration of bacteriophages (PFU) from water/sewage sample using double agar layer technique.</p> <p>34. Motility by hanging drop method/stab culture</p> <p>35. Methods of preservation of culture</p> <p>36. Study of Growth Curve of <i>E.coli</i></p> <p>37. Preparation of vaccine (Demonstration) and Sterility testing of Vaccine</p> <p>38. Enumeration by Breed's count</p> <p>39. Isolation and Enumeration of microorganisms- Serial dilution, Surface spread method,</p> <p>40. Isolation and Enumeration of microorganisms- Serial dilution, Pour plate method.</p>		

Course Code	Title	Credits
USBTP202	Practicals of USBT203 and USBT204	02
<ol style="list-style-type: none"> To determine enthalpy of dissolution of salt like KNO_3 Determine the rate constant for hydrolysis of ester using HCl as a catalyst Study the kinetics of reaction between Thiosulphate ion and HCl Study reaction between potassium Persulphate and Potassium Iodide kinetically and hence to determine order of reaction Study the reaction between $NaHSO_3$ and $KMnO_4$ and balancing the reaction in acidic, alkaline and neutral medium 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 V_{max} and K_m
17. Study of Effect of inhibitors on amylase enzyme activity
18. Determination of absorption maxima of $CuSO_4$ / $K_2Cr_2O_7$
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
<ol style="list-style-type: none"> 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: <ol style="list-style-type: none"> a. Creating, Saving & Operating a document, Editing, Inserting, Deleting, Formatting, Moving & Copying Text. 		

- b. Find & Replace, Spell Checker & Grammar Checker,
- c. Document Enhancement (Borders, Shading, Header, Footer),
- d. Printing document (Page layout, Margins),
- 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)