Janardan Bhagat Shikshan Prasarak Sanstha's

Changu Kana Thakur
Arts, Commerce and Science College, New Panvel
(Autonomous)

Re-accredited A+ Grade by NAAC
'College with Potential for Excellence 'Status Awarded by University Grants Commission
'Best College Award' by University of Mumbai

Affiliated to University of Mumbai with an Autonomous status

Revised Syllabus for

Program: B.Sc. Biotechnology

F.Y. B.Sc. Biotechnology

Choice based Credit & Grading system (60:40)

(To be implemented from the academic year (2019-2020)

Preamble:

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 aunique status for Biotechnology in Research and Industry.

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 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 syllabi till today had been sufficient to cater to the needs of students for building up their careers in industry and research. However, with the changing scenario at local and global level, we feel thatthe syllabus orientation should be altered to keep pace with developments in the education and industrial sector.

Theory supplemented with extensive practical skill sets will help a graduate student to avail the opportunities in the applied fields (research, industry or institutions), without any additional training. Thus, the college itself will be developing the trained and skilled man-power.

Biotechnology being an interdisciplinary subject, this restructured syllabus will combine the principles of physical, chemical, and biological sciences along with developing advanced technology.Biotechnology curricula are operated at two levels viz. undergraduate and postgraduate. The undergraduate curricula are prepared to impart primarily basic knowledge of the respective subject from all possible angles while postgraduate syllabus emphasizes on more applied courses. In addition,students are to be trained to apply this knowledge particularly in day-to-day applications of biotechnology and to get a glimpse of research.

Eligibility: As per University of Mumbai rules.

Speciality Programme: Bachelor of Science (B.Sc.)

B.Sc. in Biotechnology

- **Scheme of Examination**

The performance of the learners shall be evaluated into two components. The learner's Performance shall be assessed by Internal Assessment with 40% marks in the first component by conducting the Semester End Examinations with 60% marks in the second component. The allocation of marks for the Internal Assessment and Semester End Examinations are as shown below:-

A) Internal Assessment: 40 % 40 Marks

Sr. No.	Particular		Marks
01	One periodical class test / online examination to be conducted in the given semester		20 Marks
02	One case study / project with presentation based on curriculum to be assessed by the teacher concerned		15 Marks
	Presentation	10 Marks	
	Written Document	05 Marks	
03	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities		05 Marks

Question Paper Pattern

(Periodical Class Test for the Courses at Under Graduate Programmes)

Maximum Marks: 20
Duration: 40 Minutes
Questions to be set: 02
All Questions are Compulsory

Question No.	Particular	Marks
Q-1	Match the Column / Fill in the Blanks / Multiple Choice Questions/ Answer in One or Two Lines (Concept based Questions) (1 Marks / 2 Marks each)	10 Marks
Q-2	Answer in Brief (Attempt any Two of the Three) (5 Marks each)	10 Marks

B) Semester End Examination: 60 % 60 Marks

- **Undergraduate Programmes of F. Y. B.Sc. (Sem. I & II)**
- Duration: The examination shall be of 2 hours duration.

Question Paper Pattern

Theory question paper pattern
1. There shall be four questions of 15 marks each (30 marks with internal options). 2. On each unit there will be one question and fourth question will be based on entire syllabus. 3. All questions shall be compulsory with internal options. 4. Question may be subdivided into sub-questions a, b, c… and the allocation of marks depends on the weightage of the unit.

➢ Passing Standard

The learners to pass a course shall have to obtain a minimum of 40% marks in aggregate for each course where the course consists of Internal Assessment and Semester End Examination. The learners shall obtain minimum of 40% marks (i.e. 16 out of 40) in the Internal Assessment and 40% marks in Semester End Examination (i.e. 24 Out of 60) separately, to pass the course and minimum of Grade D, wherever applicable, to pass a particular semester. A learner will be said to have passed the course if the learner passes the Internal Assessment and Semester End Examination together.

Note: As per previous ordinance there will not be any internal examination for practical.

F.Y. B.Sc. Biotechnology

Semester -I				
Course Code	**Course Type**	**Course Title**	**Credits**	**Lectures / Week**
UBT1BCH	Core Subject	Basic Chemistry	2	3
UBT1ACH	Core Subject	Analytical Chemistry	2	3
UBT1BEC	Core Subject	Biodiversity and Ecology	2	3
UBT1BMI	Core Subject	Basic Microbiology	2	3
UBT1IBC	Core Subject	Introduction to Biotechnology and Cell Biology	2	3
UBT1GEN	Core Subject	Genetics	2	3
	Elective Subject	FC/PE/NCC/NSS	2	3
UBT1PR1	Core Subject Practicals	Practicals of UBT1BCH and UBT1ACH	2	3
UBT1PR2	Core Subject Practicals	Practicals of UBT1BEC and UBT1BMI	2	3
UBT1PR3	Core Subject Practicals	Practicals of UBT1IBC and UBT1GEN	2	3

F.Y. B.Sc. Biotechnology

Semester -II				
Course Code	**Course Type**	**Course Title**	**Credits**	**Lectures /Week**
UBT2BIC	Core Subject	Biochemistry	2	3
UBT2BOC	Core Subject	Bioorganic Chemistry	2	3
UBT2PAP	Core Subject	Plant and Animal Physiology	2	3
UBT2MOB	Core Subject	Molecular Biology	2	3
UBT2TCG	Core Subject	Tissue Culture and Good Laboratory Practices	2	3
UBT2EIB	Core Subject	Enzymology, Immunology and Biostatistics	2	3
	Elective Subject	FC/PE/NCC/NSS	2	3
UBT2PR1	Core Subject Practicals	Practicals of UBT2BIC and UBT2BOC	2	3
UBT2PR2	Core Subject Practicals	Practicals of UBT2PAP and UBT2MOB	2	3
UBT2PR3	Core Subject Practicals	Practicals of UBT2TCG and UBT2EIB	2	3

SEMESTER-I THEORY

SEMESTER-I
Basic Chemistry-I

Course Code	Title	Credits	Lectures
UBT1BCH	**Basic Chemistry**	**2**	
Course Objective : To acquaint the students with basic concepts of Chemistry like Classification and Nomenclature of Chemical compounds **Learning Outcome**: To identify and classify the organic and inorganic compounds on the basis of bond present and isomerism.			
Unit I Nomenclature and Classification	**Nomenclature and Classification of Inorganic Compounds:** Oxides, Salts, Acids, Bases, Ionic, Molecular and Coordination Compounds. **Nomenclature and Classification of Organic Compounds:** Alkanes,Alkenes, Alkynes, Cyclic Hydrocarbons, Aromatic Compounds, Alcohols, Ethers, Aldehydes , Ketones, Carboxylic Acids and its derivatives, Amines, Amides, Alkyl Halides and Heterocylic Compounds.		15 Lectures
Unit II Chemical Bonds	**Ionic Bond:** Nature of Ionic Bond, Structure of NaCl, KCl and CsCl, factors influencing the formation of Ionic Bond. **Covalent Bond:** Nature of Covalent Bond, Structure of CH_4, NH_3, H_2O, Shapes of $BeCl_2$, BF_3 **Coordinate Bond:** Nature of CoordinateBond **Non Covalent Bonds:** Van Der Waal's forces: dipole - dipole, dipole – induced dipole. **Hydrogen Bond**: Theory and Types of Hydrogen Bonding (with examples of RCOOH, ROH, Salicylaldehyde, Amides, and Polyamides).		15 Lectures

Unit III Stereochemistry	**Isomerism** – Types of Isomerism: Constitutional Isomerism (Chain, Position and Functional) and Stereoisomerism, Chirality. **Geometric Isomerism and Optical Isomerism:** Enantiomers, Diastereomers, and Racemic mixtures Cis-Trans, Threo, Erythro and Meso isomers. Diastereomerism (Cis-Trans Isomerism) in Alkenes and Cycloalkanes (3 and 4 membered ring) **Conformation**: Conformations of Ethane. Difference between Configuration and Conformation. **Configuration**, Asymmetric Carbon Atom, Stereogenic/ Chiral Centers, Chirality, Representation of Configuration by —Flying Wedge Formula. **Projection formulae** – Fischer, Newman, and Sawhorse. The Inter-conversion of the Formulae.		15 Lectures

SEMESTER I
Analytical Chemistry

Course Code	Title	Credits	Lectures
UBT2BOC	**Analytical Chemistry**	**2**	
Course Objective: To acquaint students with Concepts of Chemical calculations and Analytical Techniques, Stereochemistry **Learning Outcome** : To impart knowledge of Titrimetic and Volumetric Estimations and handling of basic Analytical Techniques like Chromatography and Colorimetry			
Unit I Calibration of Glassware's and Chemical Calculations	Calibration of pipettes, volumetric flask, and burettes. **Measurement in analytical chemistry-** SI units- fundamental units (mass, amount of substance, distance, time, temperature, current) and derived units (area, volume, density, velocity, force, pressure, energy, heat, work, power, charge, potential, resistance, frequency) (SI units and symbol only)		15 Lectures

	Calculations in Chemistry: Normality, Molarity, Molality, Mole fraction, Mole concept, Solubility, Weight ratio, Volume ratio, Weight to Volume ratio, ppb, ppm, millimoles, milliequivalents (Numericals expected).		
Unit II Titrimetry and Gravimetry	**Titrimetric Analysis**: Titration, Titrant, Titrand, End Point, Equivalence Point, Titration Error, Indicator, Primary and Secondary Standards, Characteristics and examples . **Types of Titration** –Acid –Base, Redox. Precipitation, Complexometric Titration. Acid – Base Titration.-Strong Acid *Vs* Strong Base - Theoretical aspects of Titration Curve and End Point Evaluation. Theory of Acid –Base Indicators, Choice and Suitability of Indicators. **Gravimetric Analysis:** Solubility and Precipitation, Factors affecting Solubility, Nucleation, Particle Size, Crystal Growth, Colloidal State, Ageing/Digestion of Precipitate. Co-Precipitation and Post-Precipitation. Washing, Drying and Ignition of Precipitate. (Numericals Expected).		15 Lectures
Unit III Analytical Techniques	**Methods of Separation:** Precipitation, Filtration, Distillation and Solvent Extraction. **Analytical Techniques Chromatography:** Definition, Principles, Types- Paper Chromatography, Thin Layer Chromatography And it's Applications. **Colorimetry:** Principle, Beer-Lambert's Law, Measurement of Extinction, Derivation of E = kcl, Limitations of Beer-Lambert's Law, Filter Selection.		15 Lectures

SEMESTER I
Biodiversity and Ecology

Course Code	Title	Credits	Lectures
UBT1BEC	**Biodiversity and Ecology**	**2**	
Course Objectives: To acquaint students with concept of Biodiversity and Cell Biology. **Learning Outcome:** To impart skill in handling and culture of Microorganisms.			
Unit I **Biodiversity of Plants and Animals**	Concept of Biodiversity, Taxonomical, Ecological, and Genetic Diversity, & its Significance. Hotspot of Indian biodiversity, Biodiversity conservation strategies, measuring biodiversity (α, β, γ). **Introduction to Plant Diversity:** Algae, Fungi, Bryophyta, Pteridophyta, Gymno-sperms and Angiosperms (with one example each) **Introduction to animal diversity: Kingdom Animalia**- Outline classification of non-chordatesand chordates with representative examples.		15 Lectures
Unit II **Microbial Diversity**	**Microbial Diversity: Archaebacteria**, Eubacteria, Blue-green Algae, Actinomycetes, Eumycota-Habitats, Examples, and Applications. **Bacteria:** Classification, Types, Morphology (Size, Shape, and Arrangement) Cultivation of Bacteria. Reproduction and Growth (Binary Fission, Conjugation and Endospore formation) , Significance of Bacteria **Viruses: General** Characters, Classification (Plant, Animal and Bacterial Viruses) Structure and Characterization of Viruses and Significance.		15 Lectures
Unit III **Ecosystem and Interactions**	Ecosystems, Definition and Components, Structure and Function of Ecosystems. Aquatic and Terrestrial Ecosystems, Biotic and Abiotic Factors, Trophic Levels, Food Chain and Food Web. Ecological Pyramids (Energy, Biomass and Number) Nutrient Cycle and Biogeochemical Cycles: Water, Carbon, Oxygen, Nitrogen, and Sulphur. Interactions, Commensalism, Mutualism, Predation and Antibiosis, Parasitism.		15 Lectures

SEMESTER I
Basic Microbiology

Course Code	Title	Credits	Lectures
UBT1BMI	**Basic Microbiology**	**2**	
Course Objectives: To acquaint students with basic techniques in Staining and Sterilization. **Learning Outcome:** To impart the knowledge of growth of microorganisms.			
Unit I **Microscopy and Stains**	**Microscope-** Simple and Compound: Principle. Parts, Functions and Applications. Dark Field and Phase Contrast Microscope. **Stains and Staining Solutions-**Definition of Dye and Chromogen. **Structure of Dye and Chromophore.** Functions of Mordant and Fixative. Natural and Synthetic Dyes. Simple Staining, Differential Staining and Acid Fast Staining with specific examples.		15 Lectures
Unit II **Sterilization Techniques**	Definition: Sterilization and Disinfection. Types and Applications: Dry Heat, Steam under pressure, Gases, Radiation, and Filtration. Chemical Agents and their Mode of Action - Aldehydes, Halogens, Quaternary Ammonium Compounds, Phenol and Phenolic Compounds, Heavy Metals, Alcohol, Dyes, and Detergents,Ideal Disinfectant. Examples of Disinfectants and Evaluation of Disinfectant.		15 Lectures
Unit III **Nutrition, Cultivation and Enumeration of Microorganisms**	Morphological classification, Bacteria, Endospore formation 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, Enriched, Selective and Enrichment Media. Concept of Isolation and Methods of Isolation. Pure Culture Techniques **Growth and Enumeration:** 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		15 Lectures

SEMESTER I
Introduction to Biotechnology and Cell Biology

Course Code	Title	Credits	Lectures
UBT1IBC	**Introduction to Biotechnology and Cell Biology**	**2**	
Course Objectives: To acquaint students with various fields of Biotechnology Cell Biology**Learning Outcome:**To impart the knowledge of biotechnology, cell structure functions and regulation of cell division and cell cycles.			
Unit I **Scope and Introduction to Biotechnology**	History & Introduction to Biotechnology Definition of Biotechnology, Traditional and Modern Biotechnology. Branches of Biotechnology- Plant, Animal Biotechnology, Marine Biotechnology, Agriculture, Healthcare, Industrial Biotechnology, Pharma-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
Unit II **Structure of Prokaryotic and Eukaryotic Cell**.	**Ultra-structure of Prokaryotic Cell:** Cell theory, Concept of Cell Shape and Size, Detail Structure of Slime Layer, Capsule, Flagella, Pilli, Cell Wall(Gram Positive and Negative), Cell Membrane, Cytoplasm and Genetic Material Storage Bodies and Spores **Ultra-structure of Eukaryotic Cell:** Plasma membrane, Cytoplasmic Matrix, Microfilaments, Intermediate Filaments, and Microtubules Organelles of the Biosynthetic-Endoplasmic Reticulum & Golgi Apparatus. Lysosome, Eucaryotic Ribosomes, Mitochondria, and Chloroplasts. Nucleus –Nuclear Structure, Nucleolus External Cell Coverings: Cilia And Flagella Comparison of Prokaryotic And Eukaryotic Cells.		15 Lectures
Unit III **Cell cycle, cell death and cell renewal**	Eukaryotic cell cycle, restriction point, and checkpoints. Cell division: Meiosis and Mitosis Apoptosis and necrosis -brief outline. Salient features of a transformed cell.		15 Lectures

SEMESTER I
Genetics

Course Code	Title	Credits	Lectures
UBT1GEN	**Genetics**	**2**	
Course Objectives : To acquaint students with concept of genetics **Learning Outcome:** Students will learn the basic concept of Microbial genetics Mendelian genetics any cytogenetics.			
Unit I Microbial Genetics	Genetic analysis in Bacteria- Prototrophs, Auxotrophs. Bacteriophages: Lytic and Lysogenic development of Phage. Mechanism of Genetic Exchange in Bacteria: Conjugation; Transformation; Transduction; (Generalized Transduction, Specialized Transduction) ;Bacterial Transposable Elements.		15 Lectures
Unit II Genetics Fundamentals	Mendel's Laws of Heredity Monohybrid Cross: Principle of Dominance and Segregation. Dihybrid Cross: Principle of independent Assortment. Application of Mendel's Principles Punnett Square. Mendel's Principle in Human Genetics. Incomplete Dominance and Co-dominance. Multiple Alleles. Allelic series. Variations among the effect of the Mutation. Genotype and Phenotype. Environmental effect on the expression of the Human Genes. Gene Interaction.Epistasis.		15 Lectures
Unit III Cytogenetics	**Structure and organization of eukaryotic genetic material –** Histone and non-histone proteins, nucleosome structure. Heterochromatin, Euchromatin, Polytene Chromosomes, Lampbrush chromosome. Chromosomal banding **Variation in Chromosomal Structure and Number:** Deletion, Duplication, Inversion, Translocation, Aneuploidy, Euploidy and Polyploidy and Syndromes- Klinefelter, Turner, Cri-du-Chat, Trisomy -21, Trisomy18and Trisomy 13. **Sex Determination and Sex Linkage :**Mechanisms of Sex Determination (XX-XY, ZZ-ZW, XX-XO) Dosage Compensation and Barr Body.		15 Lectures

References

1.	Organic chemistry by Bahl and Bahl
2.	Organic chemistry by Stanely Pine
3.	Concise inorganic chemistry by J.D. Lee (Chapter 3,4,8)
4.	Organic chemistry by Paula Bruice
5.	Stereochemistry of organic compound by P.S.Kalsi
6.	Organic chemistry by Solomon and Fhryle.
7.	Basic Principles In Physical & Analytical Chemistry- F.Y.BSc. Pure Chemistry- Sem. I- Unit III
8.	Prof. Mathur M.M.S Chemicaal calculations (pg. 282-318)
9.	Fundamentals of analytical chemistry- 8th edition by Skoog, West, Holler & Crouch
10.	Vogel's textbook of Quantitative analysis- 6th edition
11.	Analytical chemistry- 7th edition by Skoog, West & Holler
12.	Instrumental methods of chemical analysis by Gurdeep Chatwal & Sham Anand- 13th reprint 1998
13.	Analytical chemistry- 6th edition by Cary D. Christian
14.	Cell Biology, Genetics, Molecular Biology, Evolution and Ecology by Verma and Agarwal
15.	Biodiversity conservation and management by B. K. Singh
16.	Presscott's Microbiology, 8th edition (2010), Joanne M Willey, Joanne Willey, Linda Sherwood, Linda M Sherwood, Christopher J Woolverton, Chris Woolverton, McGrawHil Science Enginering
17.	Microbiology–6th Edition (2006), Pelczar M.J., Chan E.C.S., Krieg N.R., The McGraw Hill Companies Inc. NY
18.	Ecology and environment by P.D. Sharma
19.	Fundamentals of Microbiology- Frobisher
20.	Fundamental Principles of Bacteriology - A. J. Salle McGraw Hill
21.	Advanced Biotechnology by R.C. Dubey
22.	Biotechnology by B.D. Singh
23.	Molecular Biology of the Cell, 5th Edition (2007) Bruce Alberts
24.	iGenetics- Peter Russell -Pearson Education
25.	Genetics 5th edition- Peter Russell -Pearson Education
26.	Genetics, (2006) Strickberger MW - (Prentice Hall, India)
27.	Molecular Biology by Friefelder
28.	Cell and Molecular Biology- Concepts and Experiments—Karp – Wiley International
29.	Molecular Biology of gene by Watson

SEMESTER – I
PRACTICALS

SEMESTER I
Practicals Basic Chemistry and Analytical Chemistry

Course Code	Title	Credits	Notional Hours
UBT1PR1	**Practicals of UBT1BC and UBT1ACH**	**2**	**30 hrs**

1. Safety Measures and Practices in Chemistry Laboratory, Working and use of a Digital Balance, Functioning and Standardization of *pH* Meter, Optical Activity of a Chemical Compounds by Polarimeter.
2. Preparation of Standard (Molar, Molal and Normal solutions) and Buffer Solutions.
3. 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, and Hydrocarbon.
4. Characterization of Organic Compounds containing C, H, O, N, S, Halogen Elements (element tests to be done) Compounds belonging to the following classes: Amine, Amide, Nitro Compounds, Thiamide, Haloalkane, Haloarene.
5. Determination of strength of HCl in commercial sample by titrimetric Method.
6. Dissociation Constant of Weak Acids by Incomplete Titration Method using *pH* Meter and determination of Acetic acid in Vinegar by TitrimetricMethod.
7. Determination of the amount of Mg (II) present in the given solution complexometrically.
8. Determination of percent composition of $BaSO_4$ and NH_4Cl in the givenmixture gravimetrically.
9. Separation of Cu, Ni and Fe using Paper Chromatography and amino acids by paper chromatography.
10. Determination of fluoride ion using Colorimetry.

SEMESTER I
Practicals Diversity and Ecology and Basic Microbiology

Course Code	Title	Credits	Notional Hours
UBT1PR2	**Practicals of UBT1BEC and UBT1BMI**	**2**	**30 hrs**

1. Staining of Plant and Animal Tissues using Single and Double StainingTechniques.
2. Special Staining Technique for Cell Wall, Capsule and Endospores and FungalStaining
3. Monochrome Staining, Differential Staining, Gram Staining, and Acid Fast Staining and Romonowsky Staining.
4. Study of Plant, Animal and Microbial Groups with at least one example from each.
5. Sterilization of Laboratory Glassware and Media usingAutoclave.
6. Preparation of Media- Nutrient broth and Agar, MacConkey Agar, Sabourauds Agar.
7. Isolation of Organisms: T-streak, Polygonmethod.
8. Enumeration of microorganisms by Serial Dilution, Pour Plate, Spread PlateMethod.
9. Colony Characteristics of Microorganisms, Enumeration by Breed'scount.
10. Growth Curve of *E.coli.*
11. Aseptic transfer technique (tube to tube, tube to plate, pipette to tube).
12. Study of Winogradsky's column.
13. Study of motility stab culture technique, and hanging drop technique.
14. Special staining: - Fungal staining.
15. Study of all biotic and abiotic components of ecosystem- natural or terrestrial ecosystem or artificial ecosystem.
16. Study of permanentslides.

SEMESTER I
Practicals Biotechnology, Cell Biology and Genetics

Course Code	Title	Credits	Notional Hours
UBT1PR3	**Practicals of UBT2TCG and UBT2EIB**	**2**	**30 hrs**

1. Analysis of Milk- Methylene Blue, Resazurin Test, PhosphataseTest.
2. Meat tenderization.
3. Study of mitosis.
4. Study of meiosis.
5. Special Staining Technique for Cell Wall.
6. Special Staining Technique for Capsule.
7. Special Staining Technique for Endospores.
8. Study of Barr bodies.
9. Study of karyotypes- normal and abnormal.
10. Study of polytene and lampbrush chromosome.
11. Electron micrograph of lytic and lysogenic cycle.
12. Identification and study of types of cancer, cancer cells by permanent slides or photographs.

SEMESTER – II
THEORY

SEMESTER II
Biochemistry

Course Code	Title	Credits	Lectures
UBT2BIC	**Biochemistry**	**2**	
Course Objectives : To acquaintstudents with Bioorganic Molecules **Learning Outcome:** To impart the knowledge of Classification, Structure, and Characterization of Biomolecules.			
Unit I Chemistry of Water and Buffers	**Chemistry of Water:** Properties of Water, Interaction of Water with Solutes (Polar, Non-Polar, Charged), Non-Polar Compounds in Water – Change in its Structure and the Hydrophobic Effect, Role of Water in Bimolecular Structure and Function and Water as a Medium for Life. **Buffer solutions** – Concept of Buffers, Types of Buffers, Derivation of Henderson equation for Acidic and Basic buffers, Buffer action, Buffer capacity. (Numerical expected.) pH of Buffer Solution.		15 Lectures
Unit II Biomolecules: Carbohydrates and Lipids	**Carbohydrates**: Structure, Function, Classification, Characteristic Reactions, Physical and Chemical Properties, D & L Glyceraldehydes, structure of Monosaccharide, Disaccharides, and Polysaccharides. Isomers of Monosaccharides, Chemical Reactions for Detection of Mono., Di and Polysaccharides, **Lipids:** Classification of Lipids, Properties of Saturated, Unsaturated Fatty Acids, Rancidity, and Hydrogenation of Oils. Phospholipids: Lecithin Cephalin, Plasmalogen. Triacylglycerol-Structure and Function Sterols: Cholesterol: Structure and Function, Storage Lipids, Structural Lipids, Action of Phospholipases, steroids.		15 Lectures
Unit III Biomolecules: Proteins and Amino Acids	Structure and classification, physical, chemical and optical properties of amino acids, Nonstandard Amino acids, Titration Curve of Amino Acids. Concept of Isoelectric pH, Zwitter ion. Proteins: Classification based on Structure and Functions, primary, secondary, tertiary and quaternary structures, N-terminal (Sanger and Edmans Method) and C-terminal Analysis (Enzyme) Reactions of Amino Acids, Sorenson‘s Titration, Ninhydrin Test. Denaturation of protein.		15 Lectures

SEMESTER II
Bioorganic Chemistry

Course Code	Title	Credits	Lectures
UBT2BOC	**Bioorganic Chemistry**	**2**	
Course Objectives : To acquaint students with concepts in Thermodynamics, Kinetics and Redox Reactions **Learning Outcome :** To impart skills in Kinetics and Chemical Reactions			
Unit I Thermodynamics	**Thermodynamics:** System, Surrounding, Boundaries Sign Conventions, State Functions, Internal Energy and Enthalpy: Significance, examples, (Numericals expected.) Concept of Entropy, Entropy for Isobaric, Isochoric and Isothermal Processes. Thermodynamics–second law of thermodynamics, entropy, spontaneous change, free energy, enthalpy, adiabatic demagnetization, reactions at equilibrium, interpretation of equilibrium constants, acid and bases, solubility equilibria, biological activity, thermodynamics of ATP; Helmholtz and Gibbs free energies, relation between them.		15 Lectures
Unit II Chemical Kinetics	**Reaction Kinetics:** Rate of Reaction, Rate Constant, Measurement of Reaction Rates Order & Molecularity of Reaction, Integrated Rate Equation of First and Second order reactions (with equal initial concentration of reactants). (Numericals expected) Determination of Order of Reaction by a) Integration Method b) Graphical Method c) Ostwald's Isolation Method d) Half Time Method. (Numericals expected).		15 Lectures
Unit III Oxidation Reduction reactions	**Principals of Oxidation & Reduction Reactions:** Oxidising and Reducing Agents, Oxidation Number, Rules to assign Oxidation Numbers with examples Ions like Oxalate, Permanganate and Dichromate. Balancing Redox Reactions by Ion Electron Method. **Organic reaction mechanism**- Group transfer reaction-acyl, phosphoryl group and glycosyl group transfer; Oxidation and reduction reaction, elimination, isomerization and rearrangement Reaction that make and break C-C bond.		15 Lectures

SEMESTER II
Plant and Animal Physiology

Course Code	Title	Credits	Lectures
UBT2PAP	**Plant and Animal Physiology**	**2**	
Course Objectives: To acquaint students with plant and animal physiology **Learning Outcome:** To impart the knowledge regarding plant and animal system.			
Unit I **Plant Physiology**	Photosynthesis, Intracellular Organization of Photosynthetic System. Fundamental Reactions of Photosynthesis, Photosynthetic Pigments, Role of Light. Hill Reaction and its Significance, Light Reactions, Cyclic and Non-Cyclic Photo induced Electron Flow, Energetics of Photosynthesis, Photorespiration, Dark Phase of Photosynthesis, Calvin Cycle, C-3, C-4 and CAM pathways.		15 Lectures
Unit II **Plant and Animal Nutrition**	Plant water relations: Importance of water to plant life, diffusion, osmosis, plasmolysis,Imbibition, guttation, stomata & their mechanism of opening & closing, Concept of mineral nutrition. Defining nutrition, role of nutrients, measurement of energy expenditure, basal and resting metabolism, recommended nutrient intake and dietary allowances for different age groups. Significance of dietary carbohydrates, lipids, proteins and fibres (brief outline).		15 Lectures
Unit III **Animal Physiology**	Physiology of Human digestion. Physiology of excretion-Anatomy of Mammalian Kidney, Structure of Nephron, Urine Formation and Role of Kidney in Excretion and Osmoregulation. Physiology of Respiration, Mechanism of Respiration, Boyle's law. Blood and Circulation : Blood Composition, Structure and Function of its Constituents Blood Coagulation and Anti-Coagulants Mechanism and working of Heart in Human.		15 Lectures

SEMESTER II
Molecular Biology

Course Code	Title	Credits	Lectures
UBT2MOB	**Molecular Biology**	**2**	
Course Objectives: To acquaint students with basics of Molecular Biology **Learning Outcome:** By the end of the course the student will be able to Learn the structure of DNA and RNA, molecular details of DNA replication, Understand the reasons for DNA mutations and mechanism of DNA repair			
Unit I Biomolecules: Nucleic acids	Structure, Function of Nucleic Acids, Properties and Types of DNA, RNA. Structure of Purine and Pyrimidine Bases Hydrogen Bonding between Nitrogeneous Bases in DNA Differences between DNA and RNA, Structure of Nucleosides, Nucleotides and Polynucleotides.		15 Lectures
Unit II Replication	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.		15 Lectures
Unit III Mutation and DNA Repair	Definition and Types of Mutations. Mutagenesis and Mutagens. (Examples of Physical, Chemical and Biological Mutagens), Types of Point Mutations. DNA Repair: Photoreversal, Base excision Repair, Nucleotide Excision Repair, Mismatch Repair, SOS Repair and Recombination Repair.		15 Lectures

SEMESTER II
Tissue Culture and Good Laboratory Practices

Course Code	Title	Credits	Lectures
UBT2TCG	**Tissue Culture and Good Laboratory Practices**	**2**	
Course Objectives: To acquaint students with tissue culture and good laboratory practices. **Learning Outcome:** To impart the knowledge of plant and animal tissue culture and make the students aware aboutgood laboratory practices and biosafety guidelines.			
Unit I Plant Tissue Culture	Cell Theory, Concept of Cell Culture, Cellular Totipotency. Organization of Plant Tissue Culture Laboratory : Equipments and Instruments . Aseptic Techniques: Washing of Glassware, Media Sterilization, Aseptic Workstation, Precautions to maintain Aseptic Conditions. Culture Medium: Nutritional requirements of the explants, PGR's () and their in-vitro roles, Media Preparation. Callus Culture Technique: Introduction, Principle and Protocols		15 Lectures
Unit II Animal Tissue Culture	Basics of Animal Tissue Culture , Introduction to Cell Culture Techniques, Equipment and Sterilization Methodology. Media used in Animal Tissue Culture,Growth Factors and Growth Parameters. General Metabolism and Growth Kinetics Primary Cell Cultures: Establishment and Maintenance of Primary Cell Cultures of Adherent and Non-Adherent Cell Lines with examples. Application of Cell Cultures		15 Lectures
Unit III Good Laboratory Practices and Biosafety Guidelines	Concept of GLP, Objectives, Practicing GLP, Guidelines to GLP; Documentation of Laboratory work, Preparation of SOPs, Decontamination and Disposal, Safety measures in Laboratory- Common safety symbols, General Work Procedure, Emergency Procedure, Apparel in the Laboratory, Chemical Handling.		15 Lectures

SEMESTER II
Enzymology, Immunology and Biostatistics

Course Code	Title	Credits	Lectures
UBT2EIB	**Enzymology, Immunology and Biostatistics**	**2**	
Course Objectives: To acquaint students with concepts in Enzymes, vitamins, Immunology and Biostatistics **Learning Outcome:** To impart the skills in Enzyme Kinetics, Immunological Techniques and Biostatistics			
Unit I **Enzymes and Vitamins**	Enzymes:Definition, Classification, Nomenclature, Chemical Nature, Properties of Enzymes, Active Sites, Enzyme Specificity, Effect of pH, Temperature, Substrate Concentration on Enzyme Activity, Enzyme Kinetics, Michelis-Menten Equation. Vitamins: Fat Soluble and water soluble vitamins: Sources, biochemical applications and associated diseases.		15 Lectures
Unit II **Immunology**	Overview of Immune Systems, Cell and Organs involved T and B cells. Innate Immunity, Acquired Immunity, Local and Herd Immunity, Humoral and Cellular Immunity - Factors Influencing and Mechanisms of each. Antigens and Antibodies: Types of Antigens, General Properties of Antigens, Haptens and Superantigens Discovery and Structure of Antibodies (Framework region) Classes of Immunoglobulins, Antigenic Determinants.		15 Lectures
Unit III **Biostatistics**	Definition &Importance of Statistics in Biology Types of Data, Normal and Frequency Distribution Representation of Data and Graphs (Bar Diagrams, Pie Charts and Histogram, Polygon and Curve) Types of Population Sampling, Measures of Central Tendency, (For Raw,Ungroup & Group Data) Mean, Median, Mode Measures of Dispersion: Range, Variance, Coefficient of Variance. Standard Derivation, Standard Error.		15 Lectures

References

1.	Outline of biochemistry by Conn and Stumpf
2.	Fundamental of biochemistry by J. L. Jain.
3.	Biochemistry by Voet and Voet,(Fourth edition)
4.	Elementary Physical Chemistry by P.W. Atkins
5.	Physical Chemistry by Puri Sharma & Pathania
6.	Biochemistry by Voet& Voet- 4th edition
7.	Lehninger, Principles of Biochemistry. 5th Edition (2008), David Nelson & Michael Cox, W.H. Freeman and company, NY
8.	Organic chemistry by Bahl and Bahl
9.	Textbook of physiology by Mrutunjay K. Guttal
10.	Plant physiology by V. Verma
11.	Textbook of Medical Physiology Guyton, A.C and Hall 11th edition J.E Saunders
12.	Plant physiology by Salisbury and Ross
13.	Outlines of Biochemistry: 5th Edition, (2009), Erice Conn & Paul Stumpf ; John Wiley and Sons, USA
14.	Plant physiology by Salisbury and Ross
15.	Textbook of physiology by Mrutunjay K. Guttal
16.	Plant physiology by V. Verma
17.	Textbook of Medical Physiology Guyton, A.C and Hall 11th edition J.E Saunder
18.	Genetics: A Conceptual Approach, 5thEdition Benjamin A. Pierce
19.	iGenetics- Peter Russell -Pearson Education
20.	Genetics (5th Edition) by Peter J. Russell
21.	Microbial Genetics- Freifelder –Narosa Publishing House
22.	Introduction to plant tissue culture by M.K.Razdan
23.	Plant Tissue Culture by Kalyan Kumar De
24.	Plant Tissue Culture by K. G. Ramavat
25.	Principles and Practice of Animal Tissue culture- SudhaGangal - University Press
26.	Culture of Animal cells- Ian Freshney -- John Wiley & Sons
27.	Good Laboratory Practices and Biosafety Guidelines
28.	World Health Organization. Laboratory biosafety manual. – 3rd ed., 2004,
29.	A Guide to Biosafety & Biological Safety Cabinets ESCO.
30.	Biochemistry by U. Satyanarayana and U. Chakrapani
31.	Kuby immunology, Judy Owen , Jenni Punt , Sharon Stranford., 7th edition (2012), Freeman and Co., NY
32.	Text book of Medical Microbiology, Anantnarayan
33.	Introduction to Immunology- C V Rao- Narosa Publishing House
34.	Introduction to Biostatistics by P. K. Banerjee
35.	Biostatistics by P. N. Arora and P. K. Malhan
36.	Biostatistics by Mahajan

SEMESTER II
Practicals Biochemistry and Bio organic Chemistry

Course Code	Title	Credits	Notional Hours
UBT2PR1	Practicals of UBT2BIC and UBT2BOC	2	30 hrs

1. Spot test for carbohydrates, nucleic acid, lipids.
2. Saponification of Fats, Saponification Value of Oil or Fat.
3. Iodine value of Oil anddetermine the rate constant for the saponification reaction between ethyl acetate and NaOH by back titration method.
4. Titration curve of amino acid.
5. Study of isoelectric pH of casein.
6. Determination of pKa value of acetic acid.
7. Separation of sugars by TLC.
8. Determine the rate constant for hydrolysis of ester using HCl as a catalyst.
9. To determine enthalpy of dissolution of salt likeKNO3.
10. Study reaction between potassium Persulphate and Potassium Iodide kinetically and hence to determine order ofreaction.
11. Determination of the volume strength of hydrogen peroxide solution by titration with standardized potassium permagnate solution.
12. Study transfer of electrons (Titration of sodium thiosulphate with potassium dichromate).
13. Preparation of Buffers.

SEMESTER II
Practicals of Plant and Animal physiology &Molecular biology

Course Code	Title	Credits	Notional Hours
UBT2PR2	**Practicals of UBT2PAP and UBT2MOB**	**2**	**30 hrs**

1. Study of stomata.
2. Study of Hill'sreaction.
3. Colorimetric study of Absorption Spectrum of PhotosyntheticPigments.
4. Movement of Food in Paramoecium.
5. Activity of Salivary Amylase onStarch.
6. Analysis ofUrine.
7. Study of Mammalian Blood, Blood count using Haemocytometer.
8. Estimation of Haemoglobin in Mammalian Blood.
9. Study the effect of isotonic, hypotonic s and hyper tonic solutions on erythrocytes.
10. Study of Human Blood Groups.
11. Isolation of genomic DNA from plant source.
12. Separation of plant pigments by TLC.

SEMESTER II

Practicals of Tissue Culture, GLP & Enzymology, Iimmunology

Course Code	Title	Credits	Notional Hours
UBT2PR3	**Practicals of UBT2TCG and UBT2EIB**	**2**	**30 hrs**

1. Working and use of various Instruments used in Biotechnology Laboratory (Autoclave, Hot air Oven, Centrifuge, Incubator, Rotary Shaker, Filter Assembly, LAF, *pH* meter andColorimeter).
2. Preparation of Stock Solutions and Preparation of Media forPTC.
3. Aseptic Transfer Technique, Surface Sterilization (Seed sterilization).
4. Inoculation for CallusCulture.
5. Media Preparation and Sterilization (ATC).
6. Trypsinization of Tissue and ViabilityCount.
7. Qualitative Assay of Enzyme Amylase, Urease.
8. Qualitative Assay of Catalase and Dehydrogenease.
9. Study of antigen antibody interaction by Ouchterlony method.
10. Writing of SOP.
11. Enzyme Kinetics: Study of the effect of *pH*, Temperature on activity ofEnzyme.
12. Study of Effect of Substrate Concentration on enzyme activity and determination of V_{max} and Km.

Janardan Bhagat Shikshan Prasarak Sanstha's

Changu Kana Thakur
Arts, Commerce and Science College, New Panvel
(Autonomous)

Re-accredited A+ Grade by NAAC
'College with Potential for Excellence 'Status Awarded by University Grants Commission
'Best College Award' by University of Mumbai

Affiliated to University of Mumbai with an Autonomous status

Revised Syllabus for

Program: B.Sc. Biotechnology

S.Y. B.Sc. Biotechnology

Choice based Credit & Grading system (60:40)

(To be implemented from the academic year (2020-2021)

Preamble:

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.

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 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 syllabi till today had been sufficient to cater to the needs of students for building up their careers in industry and research. However, with the changing scenario at local and global level, we feel that the syllabus orientation should be altered to keep pace with developments in the education and industrial sector. Theory supplemented with extensive practical skill sets will help a graduate student to avail the opportunities in the applied fields (research, industry or institutions), without any additional training. Thus, the college itself will be developing the trained and skilled man-power.

Biotechnology being an interdisciplinary subject, this restructured syllabus will combine the principles of physical, chemical, and biological sciences along with developing advanced technology. Biotechnology curricula are operated at two levels viz. undergraduate and postgraduate. The undergraduate curricula are prepared to impart primarily basic knowledge of the respective subject from all possible angles while postgraduate syllabus emphasizes on more applied courses. In addition, students are to be trained to apply this knowledge particularly in day-to-day applications of biotechnology and to get a glimpse of research.

Speciality Programme: Bachelor of Science (B.Sc.)
B.Sc. in Biotechnology

Eligibility: As per University of Mumbai rules.

Scheme of Examination

The performance of the learners shall be evaluated into two components. The learner's Performance shall be assessed by Internal Assessment with 40% marks in the first component by conducting the Semester End Examinations with 60% marks in the second component. The allocation of marks for the Internal Assessment and Semester End Examinations are as shown below: -

A) Internal Assessment: 40 % **40 Marks**

Sr. No.	Particular		Marks
01	One periodical class test / online examination to be conducted in the given semester		20 Marks
02	One case study / project with presentation based on curriculum to be assessed by the teacher concerned		15 Marks
	Presentation	10 Marks	
	Written Document	05 Marks	
03	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities		05 Marks

Question Paper Pattern
(Periodical Class Test for the Courses at Under Graduate Programmes)

Maximum Marks: 20
Duration: 40 Minutes
Questions to be set: 02
All Questions are Compulsory

Question No.	Particular	Marks
Q. 1	Match the Column/Fill in the Blanks/Multiple Choice Questions/Answer in One or Two Lines.(Concept based Questions) (1 Marks / 2 Marks each)	10 Marks
Q. 2	Answer in Brief(Attempt any Two of the Three) (5 Marks each)	10 Marks

B) Semester End Examination: 60 % **60 Marks**

Undergraduate Programmes of S. Y. B.Sc. (Sem. III & IV)

Duration: The examination shall be of 2 hours duration.

Question Paper Pattern

Theory question paper pattern
1. There shall be four questions of 15 marks each (30 marks with internal options). 2. On each unit there will be one question and fourth question will be based on entire syllabus. 3. All questions shall be compulsory with internal options. 4. Question may be subdivided into sub-questions a, b, c… and the allocation of marks depends on the weightage of the unit.

Passing Standard

The learners to pass a course shall have to obtain a minimum of 40% marks in aggregate for each course where the course consists of Internal Assessment and Semester End Examination. The learners shall obtain minimum of 40% marks (i.e. 16 out of 40) in the Internal Assessment and 40% marks in Semester End Examination (i.e. 24 Out of 60) separately, to pass the course and minimum of Grade D, wherever applicable, to pass a particular semester. A learner will be said to have passed the course if the learner passes the Internal Assessment and Semester End Examination together.

Note: As per previous ordinance there will not be any internal examination for practical.

S.Y. B.Sc. Biotechnology

Semester -III				
Course Code	**Course Type**	**Course Title**	**Credits**	**Lectures / Week**
UBT3BPH	Core Subject	Biophysics	2	3
UBT3APC	Core Subject	Applied Chemistry-I	2	3
UBT3IMM	Core Subject	Immunology	2	3
UBT3CBC	Core Subject	Cell Biology and Cytogenetics	2	3
UBT3MOB	Core Subject	Molecular Biology	2	3
UBT3BPT	Skill Enhancement Elective	Bioprocess Technology	2	3
UBT3RSM	General Elective	Research Methodology	2	3
UBT3PR1	Core Subject Practical	Practical of UBT3BPH and UBT3APC	2	6
UBT3PR2	Core Subject Practical	Practical of UBT3IMM and UBT3CBC	2	6
UBT3PR3	Core Subject and Skill Enhancement Elective Practical	Practical of UBT3MOB and UBT3BPT	2	6

S.Y. B.Sc. Biotechnology

Semester -IV				
Course Code	**Course Type**	**Course Title**	**Credits**	**Lectures /Week**
UBT4BIC	Core Subject	Biochemistry	2	3
UBT4APC	Core Subject	Applied Chemistry-II	2	3
UBT4MEM	Core Subject	Medical Microbiology	2	3
UBT4ENB	Core Subject	Environmental Biotechnology	2	3
UBT4BBI	Core Subject	Biostatistics and Bioinformatics	2	3
UBT4MOD	Skill Enhancement Elective	Molecular Diagnostics	2	3
UBT4END	General Elective	Entrepreneurship Development	2	3
UBT4PR1	Core Subject Practical	Practical of UBT4BIC and UBT4APC	2	6
UBT4PR2	Core Subject Practical	Practical of UBT4MEM and UBT4ENB	2	6
UBT4 PR3	Core Subject and Skill Enhancement Elective Practical	Practical of UBT4 BBI and UBT4 MOD	2	6

SEMESTER-III THEORY

SEMESTER-III
Paper-I BIOPHYSICS (UBT3BPH)

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

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

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

Unit	Title	Credits	Lectures
UNIT I Spectroscopy and Microscopy	**Lasers:** Properties and Applications of Laser. **Spectroscopy:** • Introduction to Electromagnetic Radiation. • Types and Properties of Spectra; • Basic Laws of Light Absorption. • Spectrophotometer: -Principle, Instrumentation and Applications; • UV-Vis Spectrophotometer, Single and Dual Beam Spectrophotometer. **Microscopy:** • Electron Microscopy- principle, instrumentation applications and Preparation of Specimen, SEM, TEM. Fluorescence Microscopy.	**2**	**15**
UNIT II Heat, Sound, and Fluid Dynamics	**Heat:** • Concept of Temperature; Modes of Heat • Transfer; Measuring Temperature; Platinum Resistance Thermometer; Thermocouple and Thermistors. **Sound:** • Types of Sound Waves - Audible, Ultrasonic • and Infrasonic Waves; Doppler Effect; • Applications of Ultrasonic Waves. **Fluid Dynamics:** **Viscosity:** • Definition Flow of Liquids through Capillaries; Stokes' Law; Terminal Velocity. • Determination of 'η' by Falling Sphere Method; Viscosity Estimation by Oswald's • Viscometer. **Surface Tension:** • Definition - Surface Tension and Surface • Energy; Capillary Action; Angle of Contact; • Wettability; Temperature Dependence of • Surface Tension. • Applications in Biology.		**15**

UNIT III Electrophoretic Techniques	**Electrophoresis:** • Migration of Ions in an applied electric field; Factors affecting Electrophoretic Mobility; Moving Boundary Electrophoresis; • Principle of Electrophoresis; Supporting Matrix; • Paper Electrophoresis; AGE; • Native and SDS PAGE (reducing and • non-reducing, continuous and discontinuous); • IEF and 2D PAGE. • Staining and Detection Methods; • Gel- Documentation. Applications in biology		**15**

SEMESTER-III
Paper-II APPLIED CHEMISTRY–I (UBT3APC)

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

Learning Outcome: By the end of the course the student will be able to:
- Develop an understanding of the different aspects of Organic and Green Chemistry.
- Discuss role of Organic Compounds in Biology and Synthesis of Organic Compounds.
- Discuss role of Green Chemistry and its application in Industry.

Unit	Title	Credits	Lectures
UNIT I Organic Chemistry	**Introduction to types of Organic Reactions:** • Addition, Elimination, & Substitution reactions. • Mechanisms of Organic Reactions and Reactive intermediates, Methods of generation • General reactions of the following reactive intermediates: • Carbocation, Carbanion, Carbon free radical • Essential & Non-essential elements in biological system. • Role of metal ions in biological system. • Biological role of caboxyperoxidases, catalases and peroxidases of organic compounds.	**2**	**15**
UNIT II Synthesis of Organic Compounds	**Synthesis of Organic Compounds:** • Criteria for Ideal Synthesis, Selectivity and Yield. • Linear and Convergent Synthesis and • Multicomponent Reactions. • Microwave Assisted Organic Synthesis, • Ultrasound in Synthesis and Polymer Supported Synthesis.		**15**

UNIT III Green Chemistry and Synthesis	**Green Chemistry and Synthesis:** • Introduction to Green Chemistry; • Need and Relevance of Green Chemistry; Principles of Green Chemistry. • Green Synthesis in Industry: Green Materials, • Green Reagents, Green Solvents and Green • Catalysts.		**15**

SEMESTER-III
Paper-III IMMUNOLOGY (UBT3IMM)

Course Objective:

- The objective of this course is to familiarize students with the Immune Effector Mechanisms and various Immunotechniques.

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

- Understand the role of different types of Cells, Effector Molecules and Effector Mechanisms in Immunology.
- Understand the principles underlying various Immunotechniques.

Unit	Title	Credits	Lectures
UNIT I Effectors of Immune Response	• Haematopoiesis; Cells of the Immune System; • Primary and Secondary Lymphoid Organs. • Complement System- • Classical, Alternate and Lectin; • Regulation and Biological Effects of Complement System; • Deficiencies of Complement System	**2**	**15**
UNIT II Generation of B-Cell and T-cell Response	• Major Histocompatibility Complex-MHC-I and MHC-II- General Organization, Structures and Peptide Interactions. • Antigen processing and presentation: • Endocytic and Exocytic Pathways. • T-cell and B-cell Maturation, activation and differentiation.		**15**
UNIT III Immuno-Techniques	**Precipitation Reactions:** • Immunoprecipitation, Imunoelectrophoresis, • CIEP, Rocket Electrophoresis and • 2-D Immunoelectrophoresis. **Agglutination Reactions:** • Passive, Reverse Passive, Agglutination Inhibition. • Coomb's Test; Complement Fixation Tests, • RIA, ELISA, ELISPOT, Chemiluminescence, Western Blot, Immunofluorescence, Flow Cytometry. • Affinity chromatography. **Alternatives to Antigen-Antibody Reactions.**		**15**

SEMESTER-III
Paper-IV CELL BIOLOGY AND CYTOGENETICS (UBT3CBC)

Course Objective:

- The objective of this course is to have a firm foundation in the fundamentals of Cell Biology and Cytogenetics.

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

- Develop an understanding of the Cytoskeleton and Cell Membrane.
- Discuss the principles underlying Linkage, recombination and Mapping.

Unit	Title	Credits	Lectures
UNIT I Cytoskeleton	Overview of the Major Functions of Cytoskeleton. **Microtubules:** Structure and Composition. • MAPs: Functions- Role in Mitosis, Structural Support and Cytoskeleton Intracellular Motility. • Motor Proteins: Kinesins, Dynein; MTOCs. Dynamic Properties of Microtubules. • Microtubules in Cilia and Flagella. **Microfilaments:** • Structure, Composition, Assembly and • Disassembly. • Motor Protein: Myosin. • Muscle Contractility: Sliding Filament Model. Actin Binding Proteins: Examples of Non- • Muscle Motility. **Intermediate Filaments:** • Structure and Composition; Assembly and • Disassembly; Types and Functions. **Drugs targeting cytoskeleton-** • Colchicine, Cytochalasins, Taxol, Phalloidin, Vinblastine	**2**	**15**
UNIT II Cell Membrane	• Uptake of Nutrients by Prokaryotic Cells; Cell Permeability. • **Principles of Membrane Transport-** • Transporters and Channels; Active Transport, Passive Transport; Types of Transporters; • Types of ATP Driven Pumps - Na^+ K^+ Pump. • Cell Junctions; Cell Adhesion and Extracellular Material, • Microvilli; Tight Junctions, Gap Junctions; • Cell Coat and Cell Recognition.		**15**
UNIT III Genetic Linkage,	**Genetic Linkage:** • Morgan's experiment in Drosophila, Corn experiment **DNA recombination:**		**15**

Crossing Over and Chromosomal Mapping	• Crossing over; Holliday model of recombination; • Gene conversion and mismatch repair **Gene Mapping in eukaryotes:** • Two-point Cross; Three-point Cross • Pedigree analysis- Dominant and Recessive traits for Autosomal and Sex Chromosome; Tetrad analysis		

SEMESTER-III
Paper-V MOLECULAR BIOLOGY (UBT3MOB)

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

Learning Outcome: By the end of the course the student will be able to:
- Discuss the mechanisms associated with Gene Expression at the level of Transcription and Translation.
- Impart the knowledge of molecular Biology Techniques

Unit	Title	Credits	Lectures
UNIT I Gene Expression-Transcription	**Gene Expression- an Overview** **Transcription Process in Prokaryotes:** • RNA Synthesis; Promoters and Enhancers; • Initiation of Transcription at Promoters; • Elongation and Termination of an RNA Chain. **Transcription in Eukaryotes:** • Eukaryotic RNA Polymerases; Eukaryotic • Promoters; Transcription of Protein Coding • Genes by RNA Polymerase; Eukaryotic • Mrna's; Transcription of other genes; • Spliceosomes; RNA editing.	**2**	**15**
UNIT II Gene Expression-Translation	**Nature of Genetic Code.** Wobble Hypothesis. **Translation:** • Process of Protein Synthesis (Initiation, • Elongation, Translocation, Termination); • Post Translation Modifications. • Protein sorting. • **Introduction to operon concept**		**15**
UNIT III R-DNA Technology	• **Enzymes in genetic engineering:** • DNA Polymerases, Restriction Endonucleases, • Ligases, Reverse Transcriptases, Nucleases, Terminal Transferases, Alkaline Phosphatases, • Polynucleotide kinase **Gene cloning vectors:** • Plasmids, Bacteriophage Vectors- insertion		**15**

	• vectors, replacement vectors, Cosmids, Phagemids, Vectors for Plant and Animal Cells, • Shuttle Vectors, YAC Vectors, Expression Vectors • **Gene cartridges**		

SEMESTER-III
Paper-VI BIOPROCESS TECHNOLOGY (UBT3BPT)

Course Objective:

- The objective of this course is to understand the basics skills applied in Fermentation Technology and build a foundation for more advanced studies in Bioprocess Technology.

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

- Develop an understanding of the various aspects of Bioprocess Technology.
- Develop skills associated with screening of Industrially Important Strains.
- Understand principles underlying design of Fermenter and Fermentation Process.

Unit	Title	Credits	Lectures
UNIT I Microorganisms in Industrial Processes	**Types of Microorganisms used in Industrial Processes:** • Bacteria, Actinomycetes, Fungi and Algae. **Screening and Maintenance of Strains:** • Primary Screening and Secondary Screening; Cultivation; Preservation of Industrially Important Microbial Strains.	**2**	**15**
UNIT II Fermentor and Fermentation Processes	**Design of a Fermentor:** • Stirred Tank Fermentor- Basic Design; Parts of a Typical Industrial Fermentor. **Fermentation Media:** • Components; Design and Optimization. **Sterilization:** • Sterilization of Fermentor and Fermentation Media. **Process Parameters:** • pH, Temperature, Aeration, Agitation, Foam **Types of Fermentation:** • Surface and Submerged; Batch and Continuous, Aerobic and Anaerobic. **Product Isolation and Purification. Study of Representative Fermentation Processes:** Outline of Penicillin and Ethanol Production by Fermentation along with flow diagram**.**		**15**
UNIT III In-vivo and In-vitro Assay of	**Assay of Industrial Products:** • Chemical and Biological; Types and Subtypes; Kinetics. • Advantages and Disadvantages. • Half-Life Determination of Pharmacological		**15**

Industrial Products	Products. • Overview of Bioavailability and Bioequivalence Studies		

SEMESTER-III
Paper-VII RESEARCH METHODLOGY (UBT3RSM)

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

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

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

Unit	Title	Credits	Lectures
UNIT I Introduction to Research Methodology and Research Problem	• Meaning of Research; Objectives of Research; • Motivation in Research; Types of Research; Research Process; Criteria of Good Research; What is a Research Problem? Selecting the Problem; Necessity of Defining the Problem; Technique Involved in Defining a Problem. Developing a Research Plan, Types of Data and Data collection Methods,Case Study Method	**2**	**15**
UNIT II Research Design, Interpretation and Report Writing	• Meaning of Research Design; Need for Research Design; Features of a Good Design; Important Concepts Relating to Research Design; Different Research Designs; Basic Principles of Experimental Designs; • Interpretation and Report Writing • Meaning of Interpretation, Why Interpretation? Technique of Interpretation, Precautions in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports • Oral Presentation		**15**
UNIT III Introduction to Scientific Writing	• **Introduction and Process of Scientific Writing :** • Types of Scientific writing, Process of Scientific Writing: Thinking, Planning, Rough Drafts and Revising Contents.		**15**

	• How to write a research paper and research project proposal? , • Abstract Writing, Main content, • Hour- glass Model of Research paper writing, Review of Literature, Bibliography, • Ethics in Scientific writing and research Publication: Plagiarism-Introduction to Plagiarism, Examples of Plagiarism		

PRACTICALS

SEMESTER III		
Course Code	**Title**	**Credits**
UBT3PR1 (Practical of UBT3BPH and UBT3APC)	1. Study of Absorption Spectra of Colored Compounds ($CuSO_4$, $KMnO_4$). 2. Verification of Beer-Lambert's Law. 3. Extraction of Plasmid DNA and Separation by Agarose Gel Electrophoresis. 4. Determination of Purity of Plasmid DNA using UV Spectrophotometry. 5. Study of the Structure and Function of an Electron Microscope (Visit /Video Demonstration - including Sample Preparation and Staining). 6. Demonstration of Structure and Working of a Fluorescence Microscope (Stained Preparation). 7. Electrophoresis of Proteins by PAGE and SDS-PAGE. 8. Purification of any TWO Organic Compounds by Recrystallization Selecting Suitable Solvent. 9. Organic Estimations: Acetone, Amide, Benzoic Acid. 10. Organic Preparations : a. Acetylation of Primary Amine (Preparation of Acetanilide). b. Base Catalyzed Aldol Condensation (Synthesis of Dibenzalpropanone).	**2**
UBT3PR2 (Practical of UBT3IMM and UBT3CBC)	1. Complement Fixation Test (CFT). 2. Passive Agglutination- RA Factor Test. 3. Immunoelectrophoresis. 4. ELISA (Kit-based) - HEPALISA. 5. DOT-ELISA. 6. Western Blotting - Demonstration. 7. Flow Cytometry - Lab Visit.	**2**

	8. Mapping based on Tetrad Analysis and Three Point Cross. 9. Pedigree Analysis- Autosomal and Sex-Linked.	
UBT3PR3 (Practical of UBT3MOB and UBT3BPT)	1. Study of *E.coli* Diauxic Growth Curve- (Lactose and Glucose). 2. Study of lac Gene Expression using Blue-White Selection. 3. Expression of β-galactosidase and Measurement of Activity. 4. Screening for an Antibiotic Producing Strain of Microorganism. 5. Screening for an Alcohol Producing Strain of Microorganism. 6. Lab Scale Production of Penicillin (Static and shaker). 7. Purification of Penicillin from Broth Culture of Penicillium spp. by Solvent Extraction. 8. Lab Scale Production of Ethanol. 9. Purification of Ethanol from Broth Culture of *Saccharomyces* spp. by Distillation. 10. Estimation of Penicillin from Recovered Broth by Chemical (Iodometric) Method. 11. Estimation of Penicillin from Recovered Broth by Biological (Bioassay) Method. 12. Estimation of Alcohol from Recovered Broth by Dichromate Method.	**2**

SEMESTER-IV THEORY

SEMESTER-IV
Paper-I BIOCHEMISTRY (UBT4BIC)

Course Objective:

- The objective of this course is to gain an insight into the Metabolic Processes associated with Catabolism of Carbohydrates, Amino Acids, Lipids and Nucleotides.

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

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

Unit	Title	Credits	Lectures
UNIT I Carbohydrate Metabolism, ETS and Energy Rich Compounds	**Carbohydrate Metabolism:** • Glycolytic Pathway and its Regulation, Homolactic Fermentation; Alcoholic Fermentation; Energetics of Fermentation; Citric Acid Cycle and its Regulation; • Gluconeogenesis; Pentose Phosphate Pathway; Glyoxalate Pathway; Reductive TCA. • (Sequence of Reactions, Regulation, Energy Yield and Metabolic Disorders of the above Pathways) **Electron Transport System:** • Electron Transport and Oxidative • Phosphorylation. Inhibitors of ETS. **Energy Rich Compounds:** • ATP as Energy Currency, Structure of ATP, • Hydrolysis, Other Energy Rich Compounds • other than ATP like PEP, Creatine Phosphate	**2**	**15**
UNIT II Amino Acid Metabolism	**Amino Acid Breakdown:** • Deamination, Transamination, Urea Cycle, • Breakdown of Glucogenic and Ketogenic, Amino Acids. **Amino Acids as Biosynthetic Precursors:** • Biosynthesis of Epinephrine, Dopamine, • Serotonin, GABA, Histamine, Glutathione. • (Sequence of Reactions, Regulation and • Metabolic Disorders of the above Pathways)		**15**
UNIT III Lipid and Nucleotide Metabolism	**Lipid Metabolism:** • Mobilization, Transport of Fatty Acids. • Beta, Alpha and Omega Oxidation of Saturated • Fatty Acids; Oxidation of Unsaturated Fatty Acids; Oxidation of Odd Chain Fatty Acids. • Energy Yield, Ketone Body Breakdown to • Yield Energy.		**15**

	• (Sequence of Reactions, Regulation, Energy Yield and Metabolic Disorders of the above Pathways) **Nucleotide Metabolism:** • Degradation of Purines and Pyrimidines.		

SEMESTER-IV
Paper-II APPLIED CHEMISTRY – II (UBT4APC)

Course Objective:
- The objective of this course is to have a firm foundation of the fundamentals and applications of current Chemical Theories for the Physical World.

Learning Outcome: By the end of the course the student will be able to:
- Develop an understanding of the different aspects of Analytical Chemistry.
- Gain knowledge of Natural Product Chemistry and related acquired skills.
- Gain an understanding of basic concepts in Polymer Chemistry and Nanomaterials.

Unit	Title	Credits	Lectures
UNIT I Sampling and Separation techniques	**Sampling:** • Importance of sampling and sampling techniques. • Types of sampling- Random and Non-Random, • Sampling of solids, Liquids and Gases. **Separation techniques:** • Solvent Extraction • Partition Coefficient and Distribution Ratio, Extraction Efficiency, Separation Factor, Role of Complexing Agents, Chelation, Ion Pair Formation, Solvation, Soxhlation • Centrifugation: Basic principles of sedimentation, Instrumentation and application of centrifuges and ultra-centrifuges • Density gradient centrifugation	**2**	**15**
UNIT II Natural Product Chemistry	**Natural Product Chemistry:** • Primary and secondary metabolites. **Classification of natural products:** • Alkaloids, terpenoids, saponins, coumarin, Phenolics, Essential oils and steroids. **Herbs with medicinal properties:** • Curcuma longs, Ocimum tenuiflorum, Bacopa monnieri, Cuminum cyminum. **Chromatographic Separation of natural products:** • Gas chromatography and its application's		**15**

	• Liquid chromatography: HPLC and its applications, HPTLC for Separation and analysis of natural products.		
UNIT III Polymers	**Polymers:** • Introduction to polymers • Types of polymers- Monomer, polymer, • Homopolymer, copolymer, Thermoplastics • And Thermosets, Biodegradable polymers. **Nanomaterials:** • Introduction to Nanomaterials. • Forms of Nanomaterials: Nanoparticles, Nanofilms and Nanotubes • Synthesis and Characterization of Nanomaterials. • Applications of Nanomaterials.		**15**

SEMESTER-IV
Paper-III MEDICAL MICROBIOLOGY (UBT4MEM)

Course Objective: The objective of this course is to gain insight into Disease Factors and Processes and Diseases Caused by Microorganisms.

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

- List the factors playing a role in causing a disease.
- Discuss the various aspects of Systemic Infections including Causative Agents, Symptoms and Prophylaxis.
- Gain the technical capability of handling, isolating and identifying various Bacteria.

Unit	Title	Credits	Lectures
UNIT I Infectious Diseases	**Host Parasite Relationship:** • Normal Flora; Factors Affecting the Course of • Infection and Disease; Mechanisms of Infection and Virulence Factors. **Infection:** • Patterns of Infection; Types of Infections; Signs and Symptoms; Epidemiology and Epidemiological Markers. **Diseases:** • Origin of Pathogens; Vectors; Acquisition of Infection; Koch's Postulates.	**2**	**15**
UNIT II Medical Microbiology- Causative Organisms- I	**Skin :***S. aureus, S. pyogenes.* **Respiratory Tract Infections :** • *M. tuberculosis, S. pneumonia* (Characteristics, Transmission, Course of Infection, Lab Diagnosis, Management of TB, Prevention and Control, Immuno and Chemoprophylaxis, DOTS and MDR). **Urinary Tract Infections:** • *E. coli*: Characteristics, Virulence, Clinical disease, and *E. coli* Infections. *Proteus*.		**15**

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

SEMESTER-IV
Paper-IV ENVIRONMENTAL BIOTECHNOLOGY (UBT4ENB)

Course Objective: The objective of this course is to gain awareness about different Types of Environmental Pollution and Related Issues.
Learning Outcome: By the end of the course the student will be able to:
- Gain an understanding of the causes, types and control methods for Environmental Pollution.
- Application of different life forms in Environmental Remediation.

Unit	Title	Credits	Lectures
UNIT I Environmental Pollution	**Sources of Pollution** **Air Pollution:** • Types; Sources; Classification of Air Pollutants; Air Pollution Monitoring and • Control. **Water Pollution:** • Causes, Types and Classification; • Eutrophication; Assessment of Water Quality- • Pollutant Monitoring and Control; **Soil and Solid Waste Pollution:** • Characteristics of Wastes, Impacts of Solid • Waste on Health, Occupational Hazards and • Control. **Soil Erosion:** • Concept, Causes and Effects.	**2**	**15 Lectures**
UNIT II Global Environmental Problems and Issues	**Green House Effect:** • Factors Responsible for Green House Effect; • Green House Gases. • Global Warming; • Ozone Depletion; • Kyoto Protocol; • UV Radiation; Acid Rain.		**15 Lectures**
UNIT III Bioremediation	• Concept of Bioremediation. • Microorganisms in Bioremediation, • Mycoremediation and Phytoremediation. • Bioremediation Technologies. • Measuring Bioremediation in the Field.		**15 Lectures**

	• Bioaugmentation and Biostimulation. • Monitoring the Efficacy of Bioremediation.		

SEMESTER-IV
Paper-V BIOINFORMATICS and BIOSTATISTICS (UBT4BBI)

Course Objective: The objective of this course is learning and understanding basic concepts of Bioinformatics and Biostatistics.

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

- Gain an understanding of the basic concepts of Bioinformatics and Biostatistics.
- Understand the tools used in Bioinformatics.
- Apply the various Statistical Tools for Analysis of Biological Data.

Unit	Title	Credits	Lectures
UNIT I Introduction to Computers and Biological Databases	**Computer Basics:** • Organization of a Computer; I/O Units; Computer Memory; Processor; Binary Arithmetic, Architecture; Operating System. **Internet Basics:** • Connecting to the Internet, E-mail, FTP, www, Difference between www and Internet. **Biological Databases:** • Classification of Databases - Raw and Processed Databases; Primary (NCBI), Secondary (PIR) and Tertiary or Composite (KEGG) Databases; Structure and Sequence Databases. • Specialized Databases - Protein Pattern Databases; Protein Structure and Classification Databases (CATH/SCOP). **Genome Information Resources:** • DNA Sequence Databases Specialized Genomic Resources. • Protein Databases based on Composition, • Motifs and Patterns. **Protein Structure Visualization Software:** • RasMol, Cn3D, Jmol	**2**	**15 Lectures**
UNIT II BLAST and Sequence Alignment	**BLAST and Sequence Alignment:** • BLAST and its Types; Retrieving Sequence using BLAST. **Pairwise Alignment:** • Identity and Similarity; Global and Local Alignment; Pairwise Database Searching. **Multiple Sequence Alignment:** • Goal of Multiple Sequence Alignment; Computational Complexity; Manual		**15 Lectures**

	Methods; Simultaneous Methods; Progressive Methods; Databases of Multiple Alignment; Secondary Database Searching, MSA and Phylogenetic Trees.		
UNIT III Biostatistics	**Theory and Problems based on: Correlation analysis-** • Coefficient of correlation: Direct, Short-cut method, Spearman's Rank Correlation coefficient, Scatter Diagram **Theory and Problems based on: Regression analysis-** • Regression coefficients, Regression lines (Linear Regression X on Y and Yon X). **Steps in Testing Statistical Hypothesis** **Parametric Tests** • Z Test – Single Mean and Two Means, • t-Test – Single Mean, Paired and Unpaired; **Non-Parametric Tests**-Chi-Square Test.		**15 Lectures**

SEMESTER-IV
Paper-VI MOLECULAR DIAGNOSTICS (UBT4MOD)

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

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

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

Unit	Title	Credits	Lectures
UNIT I Basics of Molecular Diagnostics	• Overview of Molecular Diagnostics **Characterization and analysis of Nucleic Acids and Proteins**: • Extraction, Isolation and Detection of DNA, • RNA and Proteins; Restriction Endonucleases and Restriction Enzyme Mapping. **Hybridization Techniques:** • Southern, Northern, Western and FISH; Markers, Probes and its Clinical Applications.	**2**	**15 Lectures**
UNIT II Nucleic Acid Amplification Methods	**Target amplification:** • PCR - General Principle; Components of a Typical PCR Reaction; Experimental Design; Primer Designing; Control of PCR Contamination and Mispriming; PCR Product Clean-up and Detection.		**15 Lectures**

	PCR Types: • Reverse Transcriptase and Real Time PCR. **Probe amplification:** • Ligase Chain Reaction		
UNIT III Molecular Biology based Diagnostics	**DNA Polymorphism and Identification:** • RFLP and Parentage Testing; • RFLP and Sickle-Cell Anaemia. **Molecular Diagnostics for Infectious Diseases** • Molecular Testing for Neisseria, Molecular Diagnosis for HIV-1; **Genetic Counselling and Molecular Diagnosis** • Genetic Testing- Need and Uses; genetic Counselling. **Ethical, Social and Legal Issues to Molecular Genetic Testing**		**15 Lectures**

SEMESTER-IV
Paper-VII ENTERPRENEURSHIP DEVELOPMENT (UBT4END)

Course Objective: To develop and systematically apply an Entrepreneurial way of thinking that will allow identification and creation of Business Opportunities.

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

- Develop an understanding of the systematic process and to select and screen a Business idea.
- Design strategies for successful implementation of ideas.
- Write a Business Plan.
- Understand different forms of Intellectual Property protection

Unit	Title	Credits	Lectures
UNIT I Introduction to Entre-preneurship Development	Concept of Entrepreneur; • Entrepreneurship; • Need and Importance; • Factors Influencing Entrepreneurship; • Essentials of a Successful Entrepreneur	**2**	**15 Lectures**
UNIT II Setting-up, Planning of an Enterprise and Bio business	**Setting-up of an Enterprise** • Location of Enterprise; Real Estate and Human Resource Planning, Financial Planning; Role of Government and Financial • Institutions in Entrepreneurship Development; Raising Money from Venture • Capitalists, Government Grants **Preparation of a Business Plan** **Innovation & entrepreneurship in Bio-business**		**15 Lectures**

	• Introduction and scope in Bio-entrepreneurship, types of bio-industries and competitive dynamics between the sub-industries of the bio sector		
UNIT III Intellectual Property Rights (IPR)	• What is Intellectual Property? • Types of IPR, Patents, Copyright, Trademarks, Trade secret, Geographical indications, Traditional knowledge and Protection of undisclosed information. • Registered (Industrial) design, Brand, Logo, Regulatory Affairs, Corporate Law, IPR generation and Protection. • Patenting Biotechnological Inventions.		**15 Lectures**

PRACTICALS

SEMESTER III		
Course Code	**Title**	**Credits**
UBT4PR1 (Practicals of UBT4BIC and UBT4APC)	1. Determination of Lactate Dehydrogenase (LDH) Activity in Blood Serum. 2. Determination of Total, LDL and HDL Cholesterol in Serum. 3. Organ Function Tests: Liver (SGPT, SGOT); Kidney (Urea from Serum). 4. Estimation of Uric acid and Creatinine in Urine. 5. Qualitative Detection of Ketone Body in Urine. 6. Isolation of Mitochondria and Demonstration of ETC using a Marker Enzyme. 7. Separation of Binary (Solid-Solid) Mixture (Min 4 Compounds). 8. Identification of Organic Compound of Known Chemical Type (Min 4 Compounds). 9. HPLC analysis and interpretation of any one secondary metabolite from plants 10. Analysis of essential oils from any plant source using GC. 11. HPTLC fingerprint analysis of any one medicinally important plant. 12. Chemical and Biological Synthesis of Silver Nanoparticles and its characterisation by UV- Vis Spectrophotometer.	**2**

UBT4PR2 **(**Practicals of UBT4MEM and UBT4ENB)	1. Identification of *S.aureus*-Isolation, Catalase, Coagulase Test. 2. Identification of *E.coli*-Isolation, Sugar Fermentations, IMViC. 3. Identification of *Salmonella*- Isolation, Sugar Fermentations, TSI Slant. 4. Identification of *Shigella*- Isolation, Sugar Fermentations, TSI Slant. 5. Identification of *Proteus*- Isolation, Sugar Fermentations, IMViC. 6. Identification of *Pseudomonas* - Isolation, Urease test, Oxidase Test, TSI Slant. 7. RPR Test (Kit Based). 8. Permanent Slide- *Mycobacterium*. 9. Biological Oxygen Demand (BOD). 10. Chemical Oxygen Demand (COD). 11. Isolation of Bacteria from Air by Gravity Sedimentation Method. 12. Most Probable Number (MPN) – Presumptive, Confirmed and Completed tests. 13. Bioremediation of metal. 14. Visit to STP / CETP	**2**
UBT4PR3 **(**Practicals of UBT4 BBI and UBT4 MOD)	1. Familiarization with NCBI, EMBL, DDBJ, PIR, KEGG Databases. 2. Use of NCBI BLAST Tool. 3. Pairwise and Multiple Sequence Alignment and Phylogeny. 4. Classification of Proteins using CATH/SCOP. 5. Visualization PDB Molecules using Rasmol/Raswin. 6. Handling and Calibration of Micropipette. 7. Isolation, Quantitative Analysis and AGE of Genomic DNA from Bacteria and Yeast. 8. Isolation and Detection of RNA from Bacteria and Yeast. 9. Restriction Enzyme Digestion. 10. RFLP- Kit Based. 11. Primer Designing through Open Online Source NCBI- BLAST. 12. DNA Amplification – PCR. 13. Problems based on Correlation and Regression analysis 14. Problems based on Parametric an Non-parametric tests	**2**

REFERENCES:

1. Biotechnology: Environmental Processes- Rehm and Reed- Wiley
2. Molecular Biotechnology- Glick and Pasterman ASM Press
3. Food Microbiology- Frazier
4. Industrial Microbiology- A. H. Patel
5. Industrial Microbiology- L. E. Casida- John Wiley & Sons
6. Introductory Biostatistics. 1st edition. (2003), Chap T. Le. John Wiley, USA
7. Methods in Biostatistics- B. K. Mahajan –Jaypee Brothers
8. Outlines of Biochemistry: 5th Edition, (2009), Erice Conn & Paul Stumpfohn Wiley and Sons, USA
9. Principles of Biochemistry, 4th edition (1997), Jeffory Zubey, McGraw-Hill College,USA
10. Lehninger, Principles of Biochemistry. 5th Edition (2008), David Nelson Michael Cox, W.H. Freeman and company, NY.
11. Fundamentals of Biochemistry. 3rd Edition (2008), Donald Voet & Judith Voet , John Wiley and Sons, I. USA
12. Biochemistry: 7th Edition, (2012), Jeremy Berg, Lubert Stryer, W.H.Freeman and company, NY
13. An Introduction to Practical Biochemistry.3rd Edition, (2001), David Plummer, Tata McGraw Hill Edu.Pvt.Ltd. New Delhi, India
14. Biochemical Methods.1st , (1995), S.Sadashivam, A.Manickam, New Age International Publishers, India
15. Textbook of Biochemistry with Clinical Correlations, 7th Edition, Thomas M. Devlin, January 2010,
16. Proteins: biotechnology and biochemistry, 1stedition (2001), Gary Walsch, Wiley, USA
17. Biochemical Calculations, 2nd Ed., (1997) Segel Irvin H., Publisher: John Wiley and Sons, New York.
18. Enzymes: Biochemistry, Biotechnology & Clinical chemistry, (2001) Palmer Trevor, Publisher: Horwood Pub. Co., England.
19. Microbiology–6th Edition (2006), Pelczar M.J., Chan E.C.S., Krieg N.R., The McGraw Hill Companies Inc. NY
20. Presscott‘s Microbiology, 8th edition (2010), Joanne M Willey, Joanne Willey, Linda Sherwood, Linda M Sherwood, Christopher J Woolverton, Chris Woolverton, McGrawHil Science Enginering, USA
21. Text book of Medical Microbiology, Anantnarayan
22. Microbiology- Frobisher
23. General Principles of Microbiology- Stanier
24. Fundamental Principles of Bacteriology - A. J. Salle McGraw Hill
25. Genetics, (2006) Strickberger MW - (Prentice Hall, India)
26. Human Genetics- A. M. Winchester – MacMillan Press
27. Kuby immunology, Judy Owen , Jenni Punt , Sharon Stranford., 7th edition (2012), Freeman and Co., NY
28. Textbook of basic and clinical immunology, 1st edition (2013), Sudha Gangal and Shubhangi Sontakke, University Press, India
29. Immunology, 7th edition (2006), David Male, Jonathan Brostoff, David Roth, Ivan Roitt, Mosby, USA.
30. Introduction to Immunology- C V Rao- Narosa Publishing House
31. Cell and Molecular Biology – De Robertis- Lippincott Williams& Wilkins

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

Janardan Bhagat Shikshan Prasarak Sanstha's

CHANGU KANA THAKUR
ARTS, COMMERCE & SCIENCE COLLEGE, NEW PANVEL (AUTONOMOUS)

Re-accredited 'A+' Grade by NAAC
'College with Potential for Excellence' Status Awarded by UGC
'Best College Award' by University of Mumbai

Affiliated to University of Mumbai with an autonomous Status

Revised Syllabus of

Program: T.Y. B.Sc. Biotechnology

(Semester V & VI)
Choice Based Credit & Grading System (60:40)

(To be implemented from Academic Year 2021-2022)

T.Y. B.Sc. Biotechnology Course Structure

(Semester V)

Course code	Title	Theory/ Practical	Marks	Credits	No. of Lectures & Practical
UBT5CBI	Cell biology	Theory	100	2.5	60
UBT5MMI	Medical Microbiology & Instrumentation	Theory	100	2.5	60
UBT5GMB	Genomes and Molecular Biology	Theory	100	2.5	60
UBT5MBI	Marine Biotechnology	Theory	100	2.5	60
UBT5PR1	Cell biology+ Medical Microbiology & Instrumentation	Practical	100	3.0	72
UBT5PR2	Genomes and Molecular Biology+ Marine Biotechnology	Practical	100	3.0	72
UBT5BIS	Applied Component: Biosafety	Theory	100	2.0	48
UBT5PR3	Applied Component: Biosafety	Practical	100	2.0	48
		TOTAL	**800**	**20**	**480**

(Semester VI)

Course code	Title	Theory/ Practical	Marks	Credits	No. of Lectures & Practical
UBT6BIC	Biochemistry	Theory	100	2.5	60
UBT6IMI	Industrial Microbiology	Theory	100	2.5	60
UBT6PNE	Pharmacology and Neurochemistry	Theory	100	2.5	60
UBT6ENB	Environmental Biotechnology	Theory	100	2.5	60
UBT6PR1	Biochemistry + Industrial Microbiology	Practical	100	3.0	72
UBT6PR2	Pharmacology - Neurochemistry and Environmental Biotechnology (50M)+ Project work (50M)	Practical	100	3.0	72
UBT6ABT	Applied Component: Agribiotechnology	Theory	100	2.0	48
UBT6PR3	Applied Component: Agribiotechnology	Practical	100	2.0	48
		TOTAL	**800**	**20**	**480**

Preamble:

Biotechnology is one of the youngest branches of Life Science, which has expanded and established as an advanced interdisciplinary applied science in the 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.

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 leading 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 need of the hour is to design appropriate syllabi which keeps pace with changing times and technology with emphasis on applications while elucidating technology in depth. The syllabi till today had been sufficient to cater to the needs of students for building up their careers in industry and research. However, with the changing scenario at local and global level, we feel that the syllabus orientation should be altered to keep pace with developments in the education and industrial sector. Theory supplemented with extensive practical skill sets will help a graduate student to avail the opportunities in the applied fields (research, industry or institutions), without any additional training. Thus, the college itself will be developing trained and skilled man-power.

Biotechnology being an interdisciplinary subject, this restructured syllabus will combine the principles of physical, chemical, and biological sciences along with developing advanced technology. Biotechnology curricula are operated at two levels viz. undergraduate and postgraduate. The undergraduate curricula are prepared to impart primarily basic knowledge of the respective subject from all possible angles while postgraduate syllabus emphasizes on more applied courses. In addition, students are to be trained to apply this knowledge particularly in day-to-day applications of biotechnology and to get a glimpse of research.

The current syllabus includes all basic concepts of biological sciences. Students will also be introduced with emerging fields in Biotechnology like Marine biotechnology, Environmental biotechnology, Pharmacology, Agribiotechnology etc. Project component has been introduced in the curriculum to provide good quality self-learning. It is hoped that the revised syllabus shall serve its objective of promoting outcome-based learning to meet the changing needs of the biotechnology sector.

Teaching pattern: One (01) Credit would be of thirty- forty (30-40) learning hours; of this more than fifty percent of the time will be spent on 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 (60L as classroom teaching and 15 lectures as Notional hours/ paper). Each lecture duration would be for 48 min. The names of the reference books provided in the syllabus are for guidance purposes only. Students and faculty are encouraged to explore additional reference books, online lectures, videos, science journals for latest/ additional information.

Examination pattern: The performance of the learners shall be evaluated into two components. The learner's Performance shall be assessed by Internal Assessment with 40% marks in the first component by conducting the Semester End Examinations with 60% marks in the second component.

Theory:

The question paper for the Term End Exam would be of 60 marks consisting of 4 Questions (15M each), of which one question from each unit in the syllabus. Questions may be subdivided into sub-questions a, b, c... and the allocation of marks depends on the weightage of the unit.

The question paper would be set for 120 marks including internal options.

Practical:

- Would be conducted over a period of 3 days; 50M each paper.
- Each student to perform 2 major and 2 minor practical for Semester V and 2 major and project presentation for Semester VI
- Viva would be conducted during the practical during Semester V; Semester VI would have ONLY project presentation
- Distribution of marks for the experiments carried out during the examination:
- Semester V (50M/ paper): Major: 20M; Minor: 10M; Viva: 10M; Journal 10M.
- Semester VI (50M/paper): Major (x2): 40M; Journal: 10M; Project 50M
- The report could be around 25-30 pages with appropriate referencing and formatting. Marks distribution for the project would be as follows: 25M documentation, 15M presentation, 10 M viva and interactions;
- Students would undertake a project for 1-2 months during the last semester for 50 M. The project should include either of the following:
  One/ more major instrumentation OR
  One / more major technique/s required in the field of interest OR
  Bioinformatics OR Biostatistics.

Programme Specific Outcomes
B.Sc. Biotechnology degree programme

PSO1 Students will learn the basic concepts of Chemistry and analytical chemistry applied in Biological Sciences.

PSO2 An education in Cell biology, Biochemistry, Animal and plant physiology, human genetics and Immunology will impart knowledge to the students about cellular structure, biomolecules, metabolic pathways, its regulation along with defense mechanisms and physiological processes in plants and animals.

PSO3 Students will also learn the concepts of biodiversity, ecology, environment and its conservation.

PSO4 Students will gain basic information of microbial cultures, sterilization methods and enzyme production. They will be taught biosafety guidelines and good laboratory practices.

PSO5 Introduction of recent topics like Drug delivery, Marine biotechnology, Bioinformatics will impart knowledge of mechanism of drug delivery, drug designing and applications of marine organisms as food, nutraceutical and cosmetics etc.

PSO6 Students will understand the principles and the applications of molecular biology and genetic engineering methods with an emphasis on the application of recombinant DNA technology to animals, plants and microbial organisms.

PSO7 The course will give the knowledge of Bioethics, IPR, entrepreneurship, scientific writing, Communication, and management skills to the students.

PSO8 Students will get hands-on training of techniques used in Cell Biology, Biochemistry, Microbiology, Immunology, Molecular Biology and Genetic Engineering.

	SEMESTER V	
Course Code	**Title**	**Credits**
UBT5CBI	**Paper-I(Cell Biology)**	**2.5**
Course Objectives	**CO1-**Students will get knowledge of different types of extracellular signals and receptors, and explain their functional significance. **CO2-**Students will get knowledge of developmental biology which includes stages, mechanisms and patterns of embryonic development. **CO3**-Students will get knowledge of plant developmental biology and stem cell biology. **CO4-**The students will be able to learn how genetics contributes to predisposition and progression of cancer. It will help the students to understand how immunotherapy is, and can be, used to treat human illness.	
Learning Outcomes	**By the end of the course the student will be able to:** • Understand the molecules involved in cell signaling. • Gain an understanding of the basic concepts of events during embryonic development and stem cell biology. • Gain insight into the biology of cancer cells.	
UNIT	**Topics**	**Lectures**
Unit-I Cell Signalling	Cell signaling and signal transduction:Introduction General Principles of Cell Signalling. Signaling via G-Protein-linked Cell-Surface Receptors Signaling via Enzyme-linked Cell-Surface Receptors Target-Cell Adaptation. The Logic of Intracellular -Signaling: Lessons from Computer-based "Neural Networks.	**15**
Unit-II Developmental Biology	Overview of how the modern era of developmental biology emerged through multidisciplinary approaches. Stages of development- zygote, blastula, gastrula, neurula cell fate & commitment – potency- concept of embryonic stem cells, differential gene expression, terminal differentiation, lineages of three germ layers, fate map. Mechanisms of differentiation- cytoplasmic determinants, embryonic induction, concept of morphogen, mosaic and regulative development Pattern formation- axis specification, positional identification (regional specification), Morphogenetic movements. Model organisms in Developmental biology: Hydra, Zebra fish, *C. elegans* etc.	**15**

Unit-III Plant Developmental Biology & Stem cell Biology	Overview of Plant Development:Embryogenesis and early pattern formation in plants; Plant Meristem Organization and Differentiation- Organization of Shoot Apical Meristem (SAM); Organization of Root Apical Meristem (RAM); Phloem differentiation. Model organisms and experimental tools in cell and developmental plant biology: *Arabidopsis thaliana.* Definition, classification and source of stem cells; Stem cells and therapeutic cloning.	**15**
Unit-IV Cancer Biology	Cancer: Introduction, Characteristics of normal cell and cancerous cell, Tumor- Benign and malignant. Types of cancer Cancer as a Micro-evolutionary Process - invasion metastasis, angiogenesis. Oncogenes and tumor suppressor genes; The Molecular Genetics of Cancer. Cancer and Virus, Cancer diagnosis and treatment, Preventive measures for cancer.	**15**

References

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

	SEMESTER V	
Course Code	**Title**	**Credits**
UBT5MMI	**Paper-II (Medical Microbiology & Instrumentation)**	**2.5**
Course Objectives	**CO1-** The students will get knowledge of viral replication strategies; and compare and contrast replication mechanisms used by viruses relevant for human disease. **CO2-**Students will learn the mechanism of action of chemotherapeutic drugs and resistance. **CO3-**Students will learn basic principles and applications of spectroscopy. **CO4-**Students will learn about new emerging diseases and new vaccine strategies.	
Learning Outcomes	By the end of the course the student will be able to: • Identify various common and new emerging diseases of human, different diagnostic techniques and various methods involved in infection control. • Compare different separation techniques & use them in research work.	
UNIT	**Topics**	**Lectures**
Unit-I Virology	Introduction to viruses-Position in biological spectrum; Virus properties. General structure of viruses, BaltimoreClassification and Taxonomy(ICTV); Cultivation of viruses, Reproduction of ds DNA phages: One step growth experiment, Temperate phages and lysogeny - lambda phage, Regulation of phage gene expression. Hepatitis /ssRNA (influenza), animal viruses and plant (TMV)virus; Virus purification and assays; Cytocidal infections and cell damage ,Viroids and Prions;	**15**
Unit-II Chemotherapeutic drugs	Discovery and Design of antimicrobial agents, Classification of Antibacterial agents, Selective toxicity, MIC, MLC; Mode of action for: • Beta lactam antibiotics: Penicillin, Cephalosporins • Glycopeptides: Vancomycin • Polypeptides: Bacitracin • Injury to Plasma membrane: Polymyxin • Inhibition of protein synthesis Aminoglycosides, Tetracycline, Chloramphenicol, Macrolides and	**15**

	Erythromycin • Inhibition of Nucleic acid synthesis: Quinolones, Rifampicin, Metronidazole • Antimetabolites:Sulphonamides, Trimethoprim, 2-deoxy D Glucose. • Antifungal drugs, Antiviral drugs Amantadine, Acyclovir, Remdesivir. Drug Resistance: Mechanism, Origin and transmission of drug resistance; Use and misuse of antimicrobial agents.	
Unit-III Common and New Emerging diseases	Introduction to new emerging diseases and causative agents like MERS, SARS, Swine flu, COVID-19, Nipah virus, Ebola virus. Diagnosis, Treatment and preventive measures for MERS, SARS, COVID-19, Nipah virus, Ebola virus. Malaria and Dengue Virus. Vaccines: Subunit Vaccines -HSV, Peptide Vaccines, Attenuated Vaccines-Cholera, Vector Vaccines-Vaccinia virus, Genetic Immunization.	**15**
Unit-IV Bio analytical techniques	Basic Principles of spectroscopy: Principle, instrumentation and applications of IR,NMR, atomic absorption and Mass spectroscopy, fluorimetry, ORD and CD. Isotopes in Biology: Detection Techniques of Radioactivity: GM counter, Scintillation counter, Autoradiography, Applications of Tracer techniques in Biology.	**15**

References

1. Principles and techniques in biochemistry and molecular biology (2010), KeithWilson and John Walker, 7th edition, Cambridge University Press.
2. Biophysics (2002) VasanthaPattabhi and N. Gautham, Kluwer Academic Publishers.
3. Physical Biochemistry: principles and applications, 2nd edition (2009), David Sheehan, John Wiley & Sons Ltd.
4. Mim's Medical Microbiology 5th edition.
5. Microbiology by Prescott Harley and Klein 5th edition Mc Graw Hill.
6. Medical Microbiology Jawetz,E., Brooks,G.E, Melnick,J.L., Butel,J.S Adelberg E. A18th edition.Medical Microbiology by Patrick Murray 5th edition.
7. Foundations in Microbiology by Talaro and Talaro Third edition W.C Brown
8. Understanding Viruses by Teri Shors.

	SEMESTER V	
Course Code	**Title**	**Credits**
UBT5GMB	**Paper-III (Genomes and Molecular Biology)**	**2.5**
Course Outcomes	**CO1-**Students will learn different techniques of gene transfer in plants to develop transgenic plants. **CO2-**Students will learn different techniques of gene transfer in animals to develop transgenic Animals. **CO3-**Students will be able to Understand the range of molecular laboratory techniques used routinely in human forensic analysis and population genetic analysis including sex typing, DNA profiling, Single Nucleotide Polymorphism (SNP) detection and DNA sequencing. **CO4-**The students will have knowledge of tools like gene sequencing and editing.	
Learning Outcomes	By the end of the course the student will be able to: • Understand the basis of gene cloning and development of transgenic animals and plants • Gain knowledge regarding recent developments in genome sequencing and editing.	
UNIT	**Topics**	**Lectures**
Unit-I Genetic Engineering of Plants	Gene transfer methods in plants: Plant transformation with the Ti plasmid of *A.tumefaciens*, Ti plasmid derived vector system. Physical and Chemical methods of transferring genes to plants: electroporation, micro-projectile bombardment, liposome mediated, protoplast fusion, PEG and calcium phosphate mediated gene transfer. Viral Vectors for plant cells transformation brief introduction. GM Crops: GM Papaya, BT Cotton, BT Brinjal, Golden Rice, Improvement of seed quality proteins. Pros. and Cons. of GM crops.	**15**
Unit-II Genetic Engineering of Animals	Gene transfer methods in Animals: Transgenic mice-methodology-retroviral method, DNA microinjection, ES method, genetic manipulation with cre-loxP. Brief introduction of vectors for animal cells. Transgenic animal recombination system. Cloning live stock by nuclear transfer. Applications of Transgenic animals: Animal models, use of transgenic animals in therapeutic, agriculture and food.	**15**

Unit-III **Tools in** **Molecular Biology**	Construction of genomic DNA libraries, cDNA libraries and chromosomal libraries. Recombinant selection and screening methods: genetic, immunochemical, Southern and Western analysis, nucleic acid hybridization, HART, HRT. Expression of cloned DNA molecules and maximization of expression. Locating genes on chromosomes: Chromosome walking and jumping. Maxam-Gilbert's method, Sanger's dideoxy method, Automated DNA sequencing, Pyro-sequencing.	**15**
Unit-IV **Prokaryotic gene regulation** **and** **Gene editing**	Prokaryotic gene regulation: Lactose and Tryptophan operons- Gene organization and regulation. Human genome mapping and its implications in health and disease; RNAi, ZNF(Zinc finger nucleases),TALENS(Transcription Activator Like Effector Nucleases), CRISPER/Cas system(Clustered Regularly Interspersed Repeats)	**15**

References

1. iGenetics A Molecular Approach 3rd Edition Peter J. Russell.
2. Molecular Biotechnology-Principles and Applications of Recombinant DNA Technology 4th Edition Glick B.R., Pasternak J.J., Patten C.L.
3. Principles of Gene Manipulation 7th Edition Primrose S.B., Twyman R.M.
4. Biotechnology 3rd Edition S.S. Purohit.
5. Genomes 3rd Edition T.A. Brown.
6. Biotechnology B.D. Singh.
7. Gene Cloning and DNA Analysis 6th Edition T.A. Brown.
8. Genomics Cantor C.R., and Smith C.L. John Wiley & Sons. (1999

	SEMESTER V	
Course Code	**Title**	**Credits**
UBT5MBI	**Paper-IV (Marine Biotechnology)**	**2.5**
Course Objectives	**CO1** Students will learn methodological approaches that are currently being used for microbial bio-prospecting, with emphasis in the marine environment. **CO2** Students will get knowledge of various functional food ingredients and nutraceuticals obtained from marine sources. **CO3** Students will get knowledge of different applications of marine biotechnology. **CO4** Students will learn basic technical aspects of marine food technology. **CO5** Students will get knowledge of aqua farming and theirandtechniques like aquaponics and fish feed technology.	
Learning Outcomes	By the end of the course the student will be able to: • Learn methodological approaches used for microbial prospecting. • Understand marine organism and their application • Marine food products preparation and preservation methods • Learn importance of aquaculture technique, fish feed technology.	
UNIT	**Topics**	**Lectures**
Unit-I Introduction to Marine Biotechnology	Seawater composition and its properties. Classification of the marine environment. Characteristics of marine microorganisms. Specialized microorganisms: Extremophiles: barophiles, thermophiles, psychrophiles, halophiles actinomycetes, polyextremophiles and anaerobes.Marine viruses and Giruses, Giant bacteria, Marine algae and plants (seaweeds, sea grasses, mangrove plants). Microbial Bioprospecting in Marine Environments. Ocean acidification and its significance, Red tides.	**15**
Unit-II Applications of Marine Biotechnology	• Marine Bioactive as Potential Nutraceuticals and functional food and Cosmetics. • Seaweeds for removal of metal pollutants. • GFP, RFP characteristics and their applications • Green mussel adhesive protein • Biomimetics • Algal biofuels • Marine Extremozymes and their Significance.	**15**
Unit-III	Preservation and processing of marine food:Chilling method, Drying, salt curing, pickling and smoking; Freezing and cold	**15**

Marine Food Technology	storage, Thawing, Canning; Role of preservatives in processing. Packaging – fresh fish, frozen fish, individually quickfrozen (IQF) products. Fishery by-products-Fish Meal, Fish Oils, Fish Silage, Fish gelatin, Fish calcium, Chitin & Chitosan , Hydroxyapatite. Indicators for freshness determination of fish. Food Safety & Standards Authority of India (FSSAI): Ensuring food quality.	
Unit-IV Aquaculture Technology	Importance of coastal aquaculture; Aqua farms: Design and construction; Criteria for selecting cultivable species; Culture systems and management practices, Seed production in controlled condition. Fish Feed Technology: Types of feed, conventional feed vs functional feeds; Principles of feed formulation and manufacturing, Culture of Live food organisms. Bio-floc technology; Aquaponics; Zero water exchange aquaculture system; Aqua mimicry; Hydroponics; Raceway system of aquaculture. Micro-algae-indoor and mass-culture methods, Biotechnological approaches for production of important microalgae and other commercial important products.	**15**

References

1. Handbook of Fish and Marine Product Processing.
2. Se-kwon Kim, S.K. Springer Handbook of Marine Biotechnology; Springer: Berlin, Germany; Heidelberg, Germany, 2015.
3. Nollet, Leo M. L- Marine microorganisms- extraction and analysis of bioactive compounds-CRC Press_Taylor& Francis (2017)
4. R. S. K. Barnes, R. N. Hughes(auth.)-An Introduction to Marine Ecology, Third Edition-Wiley-Blackwell (1999)
5. Fabio Rindi, Anna Soler-Vila, Michael D. Guiry (auth.), Maria Hayes (eds.)-Marine Bioactive Compounds_ Sources, Characterization and Applications-Springer US (2012)
6. Reference for marine food technology https://mail.google.com/mail/u/0/?tab=rm&ogbl#inbox/FMfcgzGkXctXBqxHDBtSqmdmrVzSznfn?projector=1&messagePartId=0.1
7. Trends in Fish Processing Technology ; Edited by Daniela Borda, Anca I. Nicolau, Peter Raspor : CRC Press Taylor and Farancis Group
8. Fish Processing Technology Second edition Edited by G.M.HALL Lecturer Food Engineering and Biotechnology Group Loughborough University.

	SEMESTER V	
Course Code	**Title**	**Credits**
UBT5BIS	**Paper-V (Applied Component: Biosafety)**	**2.0**
Course Objectives	**CO1-**Students will be acquainted with the biosafety regulation in Biotechnology. **CO2-**Students will be familiar with Biosafety Guidelines **CO3-**Learners will understand how to detect potential contamination risks for products. **CO4**-Students will be able to develop the concepts of biosafety in Biotechnology.	
Learning Outcomes	By the end of the course the student will be able to: • Gain an overview regarding Biosafety guidelines, various levels,role of Institutional committee. • Understand regarding Microbiological testing in pharmaceuticals & common microbial contaminants. • Gain knowledge about the regulation in r-DNA technology along with understanding of bioethics.	
UNIT	**Topics**	**Lectures**
Unit-I Introduction to Biosafety	Introduction, Biological Risk Assessment, Hazardous Characteristics of an Agent Genetically modified agent hazards; Cell cultures Hazardous Characteristics of Laboratory Procedures Potential Hazards Associated with Work Practices Safety Equipment and Facility Safeguards Pathogenic risk and management	**12**
Unit-II Biosafety Guidelines and Regulation	Biosafety guidelines integrated with Government of India; Definition of GMOs & LMOs; Regulations and Guidelines on Biosafety: Scope of Regulation, Competent Authorities, Roles of Institutional Biosafety Committee, RDAC, IBSC, RCGM, GEAC, SBCC, DLC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis, Risk Assessment and Risk management.	**12**
Unit-III Detection and testing of contaminants	Microbial Contamination in food and pharma product; Some common microbial contaminants; Microbiological Assays for pharmaceutical products; Regulatory Microbiological testing in pharmaceuticals.	**12**

Unit-IV Biosafety in Biotechnology	Concepts on biosafety in Biotechnology, Regulating rDNA technology, Regulating food and food ingredients, Genetically engineered crops, Livestock Bioethics; Contemporary issues in Bioethics. Alteration of the Nutritional Content of Food, Controversy about the Labeling of Genetically Modified Foods. Concerns about the Impact of Genetically Modified Organisms on the Environment.	**12**

References

1. Pharmaceutical Microbiology - Hugo, W.B, Russell, A.D 6th edition Oxford Black Scientific Publishers.
2. Biosafety in Microbiological and Biomedical Laboratories - 5th Edition, L. Casey Chosewood Deborah E. Wilson U.S. Department of Health and Human Services Centers for Disease Control and Prevention National Institutes of Health.
3. Molecular Biotechnology –Principles and Applications of Recombinant DNA Glick, B.R, Pasternak, J.J Patten, C.L 4th edition ASM press
4. Joshi, R.; Biosafety and Bioethics (Ed.) (2006), Isha Books, Delhi.
5. Department of Biotechnology, Ministry of Science and Technology, Government of India; Revised guidelines for safety in biotechnology. Available from: http://dbtbiosafety.nic.in/guideline/pdf/guidelines94.pdf.

	SEMESTER V	
Course Code	**Title**	**Credits**
UBT5PR1	**Practicals of Cell biology+ Medical Microbiology & Instrumentation**	**3.0**

1. Demonstration: Principle, working and applications of FTIR.
2. MIC and MLC of any one antibiotic
3. Antibiotic sensitivity test using agar cup method
4. Antibiotic sensitivity test using paper disc method
5. Antibiotic sensitivity test using ditch method.
6. Synergistic Action of two drugs
7. Cancer Biology: (Field visit and 2 page report in the journal)
8. Chick embryo candling and inoculation methods Demonstration experiment
9. Isolation of coliphages from Sewage and Determining Bacteriophage Titers (demonstration)
10. Preparation of TAB vaccine.
11. To check COVID antigen by kit method(demonstration/Video)
12. Study through permanent slides and photographs. Meristems,structure of anther, (Female gametophyte: Polygonum (monosporic) type of Embryo sac Development.
13. Dissection of embryo/endosperm from developing seeds.

	SEMESTER V	
Course Code	**Title**	**Credits**
UBT5PR2	**Practicals of Genomes and Molecular Biology + Marine Biotechnology**	**3.0**

1. Transformation in *E.coli*.
2. Conjugation
3. Replica plate
4. Genomic DNA Extraction: Animal cells.
5. Phage titration: Demonstration
6. Gradient plate technique
7. Bacterial gene expression (Kit may be used).
8. Formulation of Fish Feed using Ingredients from Plant Sources and their standardization.
9. DPPH assay for antioxidant extracted from marine algae
10. Extraction of carotenoids from marine algae/Bacteria/Fungi.
11. Extraction and estimation of Gelatin from marine source.
12. Extractionof Collagen from marine source.
13. Extraction of alkaloids from marine organisms and their separation by TLC.
14. Preparation of fish silage.

	SEMESTER V	
Course Code	**Title**	**Credits**
UBT5PR3	**Practicals of Applied Component: Biosafety**	**2.0**

1. Validation of autoclave
2. Vitamin B12 bioassay
3. To check sterility of injectable.
4. Testing for adulterants in food.
5. Operation and safety precautions: Fire, handling of chemicalsetc.
6. Sterile testing methods for pharmaceutical products.
7. Isolation of pathogenic bacteria from fomites onoperating room of pharmaceutical industry/ Packaging material of pharmaceutical product etc.
8. A case study on clinical trials of drugs in India with emphasis on ethical issues.
9. Case study on medical errors and negligence.
10. Case study on handling and disposal of laboratory waste.
11. Effects of storage and processing on the nutritive value of certain foods.

SEMESTER-VI

	SEMESTER VI	
Course Code	**Title**	**Credits**
UBT6BIC	**Paper-I(Biochemistry)**	**2.5**
Course Objectives	**CO1-** Students will learn the levels of protein structure and protein-ligand interactions **CO2-** Analyze the metabolism of carbohydrates and fates of various intermediate and end product. **CO3-**Students will get knowledge of different protein purification techniques. **CO4-**Students will learn about different hormones and their biochemical functions with associated disorders. **CO5-**Students will get knowledge of protein denaturation and folding.	
Learning Outcomes	Learning outcomes: By the end of the course the student will be able to: • Understand the quaternary protein ligand interactions, protein folding and degradation. • Understand the biosynthetic pathways and regulation of biomolecules like carbohydrates and lipids. • Learn the various functioning of endocrine gland secretions with their associated disorders.	
UNIT	**Topics**	**Lectures**
Unit-I Protein Biochemistry	Quaternary structure of proteins with special reference to Hemoglobin, cooperative oxygen binding andConcerted and sequential models for allosteric proteins. Protein denaturation, Folding and role of Molecular Chaperons, Protein degradation basic concept. Protein Purification techniques: Principle and applications of Dialysis, salting and salting-out, gel filtration, ion exchange, FPLC, affinity and hydrophobic interaction chromatography.	**15**
Unit-II Metabolism	Carbohydrate biosynthesis and its regulation: Peptidoglycan in Bacteria; Starch and sucrose in Plants, Glycogen in Animals, inborn errors of glycogen metabolism. Biosynthesis and regulation of Cholesterol, Atherosclerosis.	**15**
Unit-III Endocrinology-I	Classification of hormones: Mechanism of action of group I and II hormones. Hormones of Hypothalamus and pituitary gland Anterior Pituitary Hormones:GH Posterior Pituitary Hormones: Oxytocin and Vasopressin	**15**

	Thyroid hormones: Biosynthesis, Biochemical and physiological functions, disorders and thyroid function tests. Hormones that regulate Calcium metabolism: PTH and Calcitriol. Chemistry, Biochemical and physiological functions of androgens, estrogens and progesterone. Hormonal regulation of menstrual cycle, Hormonal contraception. Placental hormones.	
Unit-IV Endocrinology-II	Hormones of Adrenal Cortex: Glucocorticoids and Mineralo-corticosteroids- Biochemical and physiological functions and disorders. Hormones of Adrenal Medulla: Synthesis, Biochemical and physiological functions and disorders of Catecholamines. Hormones of pancreas: structure, biochemical and physiological functions and disorders: Insulin and glucagon. Diabetes mellitus, hypoglycemia. Glucose tolerance test. Recombinant Insulin.	**15**

References

1. Lehninger, principles of biochemistry, 7th edition (2005), David Nelson and Michael Cox W.H. Freeman and Company, New York.
2. Biochemistry, 4th edition (2010), Voet and Voet, John Wiley and sons, USA
3. Harper's Illustrated Biochemistry, 27th edition, RK Murray, DK Granner, PA Mayes and VW Rodwell, McGraw Hills publication.
4. Biochemistry, 4nd edition (2017), Satyanarayana and Chakrapani, Books & Allied (P) Ltd 5. Nutrition Science, 6th edition (2017), Srilakshmi, new age international publishers

	SEMESTER VI	
Course Code	**Title**	**Credits**
UBT6IMI	**Paper-II (Industrial Microbiology)**	**2.5**
Course Objectives	**CO1-**Students will learn the production outline of various dairy products. **CO2-**Students will learn the different modes of fermentation and Down-stream Processing. **CO3**-Students will learn to develop strategy for fermentation process development **CO4-**Students will understand the Standard operating procedures, GMP and QA and QC.	
Learning Outcomes	By the end of the course the student will be able to: • Understand various fermentation processes. • Learn outline of Down-streaming processing and understand various methods applied in solvent recovery, cell disruption & separation. • Gain knowledge regarding requirements of QA-QC along with various documentation & Audit reports.	
UNIT	**Topics**	**Lectures**
Unit-I Dairy Technology	Milk: Normal flora, changes in raw milk, Enumeration Factors affecting bacteriological quality Dairy technology Preservation methods, Pasteurization Starter Cultures Fermented products-Production process and spoilage of Cheese, Swiss and Cheddar,Butter, Yogurt and Buttermilk.	**15**
Unit-II Fermentation process	Introduction to Inoculum development, Bacterial and fungal inoculum development with one example each Scale up, Scale down Production of: Streptomycin, Protease, Glutamic acid, Lysine, ethanol production Semi-synthetic Penicillin, Wine Mushroom cultivation Biotransformation	**15**
Unit-III Down-stream Processing (DSP)	Introduction of DSP Foam separation, Types of Precipitation, Filtration, Centrifugation, Chromatography in DSP Cell disruption- physical and chemical methods; Solvent recovery, Membrane processes, Drying, Crystallization. Whole broth processing	**15**

Unit-IV QA-QC	Concept of GMP Requirements of GMP implementation, Documentation of GMP practices, Regulatory certification of GMP. Quality Control (QC): Concept of QC, Requirements for implementing QC, QA concepts: Concept of QA, Requirements for implementing. Calibration records (QA-QC), Validation of methods; Documentation of results; Audits and Audit reports.	**15**

References

1. Applied Dairy Microbiology Elmer H Marth and James L Steele Mercel Dekker Inc New York, 2nd edition
2. Fundamentals of Microbiology by Frobisher, 9th Ed
3. Microbial Technology Peppler,H.J and Perlman,D 2nd Academic Press Practicals
4. Industrial Microbiology Prescott and Dunn CBS publishers
5. Industrial microbiology by Casida
6. Industrial Microbiology by A.H. Patel
7. Dairy technology by Yadav and Grower
8. Fermentation technology by Stanbury and Whitaker
9. Pharmaceutical Microbiology by Hugo and Russel

	SEMESTER VI	
Course Code	**Title**	**Credits**
UBT6PNE	**Paper-III (Pharmacology and Neurochemistry)**	**2.5**
Course Objectives	**CO1-** Students will learn the mechanism of drug action and its dose–response relationship. **CO2-** Students will learn the mechanisms of drug delivery and action in the body. **CO3-** Students will get in depth knowledge on toxic substances and poisons ie. Toxicology. **CO4**- Students will understand the properties of cells that make up the nervous system including the propagation of electrical signals used for cellular communication.	
Learning Outcomes	By the end of the course the student will be able to: • Learn the basic concept of mechanism of drug action • Learn drugs and their poisonous effect if the administered for longer period of time • Understand the basic concept of poisons and their types. • Gain the knowledge of basic neurochemistry and action of specific drugs on the Central Nervous System.	
UNIT	**Topics**	**Lectures**
Unit-I General principles of Pharmacology	Mechanism of drug action; drug receptors and biological responses; second-messenger systems, the chemistry of drug–receptor binding; dose–response relationship: therapeutic index; ED, LD; Potency and Intrinsic Activity; Drug antagonism Definition: Drugs, Small molecules, Large Molecules/ Biologics and biosimilars with example. Similarities and Differences: Small molecules versus generics, Biologics versus Biosimilars.	**15**
Unit-II Drug Absorption Distribution Metabolism and Excretion	Absorption of drugs from the alimentary tract; factors affecting rate of gastrointestinal absorption; absorption of drugs from lungs; skin; absorption of drugs after parenteral administration factors influencing drug distribution; binding of drugs to plasma proteins; Physiological barriers to drug distribution. Drug Metabolism: sites of drug metabolism and phases of Metabolism. Drug Excretion: Renal and Non-renal Drug Elimination.	**15**

Unit-III Basic Toxicology and Regulatory Toxicology	Background Definitions; Causation: degrees of certainty Classification; Causes Allergy in response to drugs Effects of prolonged administration: chronic organ toxicity; Adverse effects on reproduction. Poisons: Deliberate and accidental self-poisoning Principles of treatment Poison-specific measures General measures; Specific poisonings: cyanide, methanol, hydrocarbons, volatile solvents, heavy metals; herbicides and pesticides; biological substance (overdose of medicinal drugs is dealt with under individual agents); Incapacitating agents: drugs used for torture; Nonmedical use of drugs.	**15**
Unit-IV Neurochemistry	Anatomy and functioning of the brain; Neuronal pathways (Introduction); Propagation of nerve impulses; Neuronal excitation and inhibition; Synapses and gap junctions; Action of Neurotoxins and neurotransmitters. Drugs affecting the Central Nervous System:-Agents Affecting Neuromuscular transmission, Sedative–hypnotic and Anxiolytic drugs, drugs Used in NeurodegenerativeDisorders, Antiepileptic Drugs.	**15**

References

1. Modern Pharmacology with clinical Applications Craig,C.R, Stitzel,R.E 5th edition.
2. Casarett&Doull's Toxicology - The Basic Science of Poisons (6th Edition).
3. Clinical Pharmacology Bennet,PN,Brown,M.J, Sharma,P 11th edition.
4. Textbook of Medical Physiology Guyton, A.C and Hall 11th edition J.E Saunders
5. Biochemistry Metzler, D.E Elsevier
6. Gerard Marshall Raj RamasamyRaveendran: Introduction to Basics of Pharmacology and Toxicology, Volume 1: General and Molecular Pharmacology: Principles of Drug Action springer.

	SEMESTER VI	
Course Code	**Title**	**Credits**
UBT6ENB	**Paper-IV (Environmental Biotechnology)**	**2.5**
Course Objectives	**CO1-** Students will learn the concepts of solar energy, wind power, geothermal energy and hydropower, biomass energy, Biogas technology and Biofuels. **CO2**- Students will understand the techniques and strategies of Industrial effluent treatment. **CO3-** Students will understand the techniques of waste water management. **CO4-** Students will be Exposed to the processes which are currently associated and taking place in industry along with their consequences on generation of hazardous waste.	
Learning Outcomes	By the end of the course the student will be able to: • Understand aspects and utilization of renewable energy sources for both domestics and industrial application. • Understand the current applications of biotechnology to environmental quality evaluation, monitoring and remediation of contaminated environments. • Identify the most common techniques for preventing, minimizing, recycling, disposing and treatment of waste and their application on site remediation.	
UNIT	**Topics**	**Lectures**
Unit-I Renewable Sources of Energy	Energy sources renewable solar energy, wind power, geothermal energy and hydropower. Biogas technology- biogas plant & types, biodigester. Biogas- composition, production and factors affecting production, uses. Biomass energy, Biofuels – ethanol production, Microbial hydrogen production, Biodiesel, Petrocrops.	**15**
Unit-II Industrial Effluent Treatment	Biological processes for industrial effluent treatment, Aerobic biological treatment- activated sludge process, CASP, advanced activated sludge processes (any two) Biological filters, RBC, FBR Anaerobic biological treatment- contact digesters, packed bed reactors, anaerobic baffled digesters, UASB Solid waste treatment: Green Manure, Bio- compost making methods Types and methods of vermicomposting, field applications. Pollution indicators, Biosensors	**15**

	Biodegradation of xenobiotics- persistent compounds, chemical properties influencing biodegradability, microorganisms in biodegradation. Use of immobilized enzymes or microbial cells for treatment.	
Unit-III Wastewater Treatment	Wastewater treatment Introduction, biological treatment, impact of pollutants on bio-treatment, Use of packaged organisms and genetically engineered organisms in waste treatment. Heavy metal pollution – sources, microbial systems for heavy metal accumulation, techniques used for heavy metal removal. Biosorption by bacteria, fungi and algae Factors affecting biosorptionand Limitations of biosorption	**15**
Unit-IV Hazardous Waste Management	Biodegradation of waste from: • Tanning industry • Petroleum industry • Paper & pulp industry • Dairy industry • Distillery • Dye industry • Antibiotic industry • Removal of oil spillage & grease deposits	**15**

References

1. Environmental Biotechnology Alan Scragg Oxford University press
2. Environmental Biotechnology M.H. Fulekar Oxford & IBH Publishing Co. Pvt. Ltd.
3. Environmental Biotechnology (Basic concepts and applications) InduShekar Thakur IK International
4. Environmental Biotechnology (Industrial pollution management) S.N. Jogdand Himalaya Publishing House

	SEMESTER VI	
Course Code	**Title**	**Credits**
UBT6ABT	**Paper-V (Applied Component: Agribiotechnology)**	**2.0**
Course Objectives	CO1-Students will be Exposed to technology and the techniques that can be used to improve the efficiency of agricultural operations like greenhouse technology. CO2-Students will develop knowledge crop improvement methods. CO3- They will gain the knowledge of different markers used in plant breeding techniques' CO4-Students will gain concept of bio-fertilizers, Symbiotic-Non symbiotic nitrogen fixation in leguminous plant, assimilation of phosphorus and biopesticides.	
Learning Outcomes	By the end of the course the student will be able to: • Understand greenhouse technology and its uses. • Understand the methods of plant improvement and use of microbes as bio-fertilizers, PGRs and bio-pesticides. • They will also learn about genetic and molecular markers in plant breeding along with DNA barcoding.	
UNIT	**Topics**	**Lectures**
Unit-I Precision Agriculture and Agriculture system	Introduction to Agriculture and Agriculture systems-Greenhouse Technology-- Types of green house, importance, functions and features of green house, Design criteria and calculation. Construction material, covering material and its characteristics, growing media, green house irrigation system. Nutrient management. Greenhouse heating, cooling and shedding and ventilation system, Computer controlled environment.Phytotrons, fertigation and roof system. Precision Cultivation- tools, sensors for information acquisition.	**12**
Unit-II Biotechnology for Crop Improvement	Production of virus free plants- shoot meristem culture, micro propagation, production of Haploid plants, somatic hybridization and cybridization, synthetic seeds. Molecular Pharming, edible vaccines. Development of salt resistant, fungal resistant and herbicide resistant plants by genetic engineering.	**12**

	Hydroponics:an overview of techniques and media used.	
Unit-III Molecular Markers in Plant Breeding	Genetic markers in plant breeding-classical markers, DNA markers (RFLP, RAPD, AFLP, SSR, SNP) Application of Molecular Markers to Plant Breeding [quantitative trait locus (QTL) mapping] Plant DNA Barcoding- Barcoding Markers (matK, rbcl, ITS, tmH-psbA), steps, recent advances, Benefits, Limitations.	**12**
Unit-IV Bio-fertilizers and Bio-pesticides	Bio-fertilizer: Nitrogen-fixing Rhizobacteria - Symbiotic Nitrogen Fixers andNonsymbiotic Nitrogen Fixers. Plant Growth Promoting Microorganisms-Phosphate-Solubilizing Microbes (PSM). Plant Growth Promotion by Fungi--MycorrhizaeArbuscularMycorrhizaeEctomycorrhizae. Microbial Inoculants -- Inocula, Carriers, and Applications, Monoculture and Co-culture Inoculant Formulations Biocontrol, Polymicrobial Inoculant Formulations. Biopesticides – types, *Bacillus thuringiensis*, insect viruses and entomopathogenic fungi (characteristics, physiology, mechanism of action and application).	**12**

References

1. M. Ajmal Ali, G. Gyulai, F. Al-Hemaid -Plant DNA Barcoding and Phylogenetics, LAP Lambert Academic Publishing (2015)
2. P. Parvatha Reddy (auth.)-Sustainable Crop Protection under Protected Cultivation Springer Singapore (2016)
3. S.B. Anderson (ed.), Plant Breeding from Laboratories to Fields, InTech,2013
4. Travis R. Glare, Maria E. Moran-Diez - Microbial-Based Biopesticides_ Methods and Protocols (2016, Humana Press)
5. Arie Altman, Paul Michael Hasegawa-Plant Biotechnology and Agriculture_ Prospects for the 21st Century-Academic Press (2011
6. Bhojwani, S.S. and Razdan 2004 Plant Tissue Culture and Practice.
7. Slater, A., Scott, N.W. & Fowler, M.R. 2008 Plant Biotechnology: The Genetic Manipulation of Plants, Oxford University Press.
8. Advanced Biotechnology by R C Dubey S Chand publication.

	SEMESTER VI	
Course Code	**Title**	**Credits**
UBT6PR1	**Practicals of Biochemistry + Industrial Microbiology**	**3.0**

1. Protein separation by salting out.
2. Demonstration of dialysis
3. Separation of components from a mixture using Affinity chromatography (Kit may be used)
4. Separation of components from a mixture using Size exclusion chromatography
5. Estimation of Milk protein-Pynes method
6. Microbial analysis of Milk by MBRT and RRT
7. Phosphatase test in Milk
8. DMC of milk sample
9. Isolation of Normal flora from Milk and curd
10. Wine production and testing.
11. Determination of blood glucose levels for detection of diabetes mellitus.
12. Determination of serum cholesterol (total, HDL and LDL ratio)
13. Estimation of Glycogen
14. Identification questions based on hormones (Case study).

	SEMESTER VI	
Course Code	**Title**	**Credits**
UBT6PR2	**Practicals of Pharmacology - Neurochemistry and Environmental Biotechnology and Project Work**	**3.0**

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

	SEMESTER VI	
Course Code	**Title**	**Credits**
UBT6PR3	**Practicals of Applied Component: Agribiotechnology**	**2.0**

1. RAPD analysis demonstration experiment.
2. Isolation of Rhizobium.
3. Isolation of Azotobacter.
4. Isolation of Phosphate solubilising bacteria
5. Rapid screening tests for abiotic stress tolerance (drought, - PEG, Mannitol& salinity NaCl).
6. To estimate the Proline content in salt stressed plants.
7. Preparation of synthetic seeds.
8. Micropropagation of suitable plant species.
9. Preparation of bio-fertilizer.
10. To observe effect of bio-fertilizer on plant growth.
11. Preparation of hydroponic solution and hydroponic culture.
12. Visit to the greenhouse facility and submission of a field visit report.

****
****