



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)

Total credits-132

(To be implemented from the academic year (2022-2023))

(Approved in the academic council meeting held on _____)

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 manpower.

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.

Choice Based Credit System (CBCS)

Revised 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 and by conducting the Semester End Examinations with 60% marks in the second component. The allocation of marks for the Internal Assessment and Semester End Examination 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	Any two tools out of these (10 Marks each) 1. Group / Individual Project 2. Presentation and write-up on the selected topics of the subjects / Case studies 3. Test on Practical Skills 4. Open Book Test 5. Quiz	20 Marks

Question Paper Pattern

(Periodical Class Test / online examination for the Courses at Under Graduate Programme)

- ❖ Maximum Marks: 20
- ❖ Duration 30 Minutes

Particular	Marks
Match the Column / Fill in the Blanks / Multiple Choice Questions / True/False / Answer in One or Two Lines (Concept based Questions) (1 Mark each)	20 Marks

B) Semester End Examination : 60%

60 Marks

- **Undergraduate Programme of F.Y. B.Sc. (Semester I and II)**
- Duration: The examination shall be of 2 hours duration.

Theory Question Paper Pattern
<ol style="list-style-type: none">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. Questions 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, in each project 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.

F.Y. B.Sc. Biotechnology

Semester -I				
Course Code	Course Type	Course Title	Credits	Lectures / Week
UBT1BIT	Core Subject	Biotechnology- I	2	3
UBT1BOM	Core Subject	Basics of Microbiology	2	3
UBT1BCH	Core Subject	Basic Chemistry- I	2	3
UBT1BOC	Core Subject	Bioorganic Chemistry- I	2	3
UBT1CBI	Core Subject	Cell Biology	2	3
UBT1GEN	Core Subject	Genetics	2	3
UBT1ESS	General Elective	Environmental Science and Sustainable Development	2	3
UBT1CAB	Skill Enhancement Elective	Computer Applications in Biotechnology		30L/Sem.
UBT1PR1	Core Subject Practical	Practical of UBT1BIT & UBT1BOM	2	6
UBT1PR2	Core Subject Practical	Practical of UBT1BCH & UBT1BOC	2	6
UBT1PR3	Core Subject Practical	Practical of UBT1CBI & UBT1ESS	2	6

F.Y. B.Sc. Biotechnology

Semester -II				
Course Code	Course Type	Course Title	Credits	Lecture /Week
UBT2BIT	Core Subject	Biotechnology- II	2	3
UBT2MAI	Core Subject	Microbiology and Immunology	2	3
UBT2BCH	Core Subject	Basic Chemistry- II	2	3
UBT2BOC	Core Subject	Bioorganic Chemistry- II	2	3
UBT2MBG	Core Subject	Molecular Biology and Genetic Engineering	2	3
UBT2PAP	Core Subject	Plant and Animal Physiology	2	3
UBT2 LSB	Ability Enhancement Course	Laboratory Skills & Biostatistics	2	3
	Skill Enhancement Elective	Communication Skills	2	30L/Sem.
UBT2PR1	Core Subject Practical	Practical of UBT2BIT & UBT2MAI	2	6
UBT2PR2	Core Subject Practical	Practical of UBT2BCH & UBT2BOC	2	6
UBT2PR3	Core Subject Practical	Practical of UBT2MBG & UBT2PAP	2	6
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SEMESTER-I THEORY

SEMESTER-I
Paper-I Biotechnology-I (UBT1BIT)

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

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

- Develop an understanding of developments in various fields of Biotechnology.
- Be able to relate to applications and benefits of Biotechnology in the fields of agriculture, livestock, human health and environment.
- Justify the Biosafety rules and its implementation.
- To understand concept and significance of IPR.

Unit	Title	Credits	Lectures
UNIT I Introduction to Biotechnology	<p>What is biotechnology? Biotechnology –an interdisciplinary biological science; Biotechnology – definition; History & Introduction to Biotechnology; Traditional and Modern Biotechnology; Scope and importance of biotechnology;</p> <p>World of Biotechnology- Plant Biotechnology, Animal Biotechnology, Pharmaceutical Biotechnology, , Industrial Biotechnology, Marine Biotechnology, Medical biotechnology, Environmental Biotechnology.</p> <p>Biotechnology in India – Bio-business in India, booming biotech market, success story of biotech market, policy initiatives; and global trends; Biotechnology research in India; Potential of modern biotechnology; Achievement of biotechnology; Prevention of misuse of biotechnology; Biotechnology Institutions in India (Public and Private Sector);</p> <p>Public Perception of Biotechnology.</p> <p>Case study: Serum Institute of India and its products</p>	2	15

<p>Unit II Applications of Biotechnology</p>	<p>Applications of Biotechnology:</p> <p>Agriculture: GM fruits- GM papaya, GM tomato, Insect resistant transgenic plants – Bt cotton, Bt brinjal, Modifications in nutrient quality – starch, oilseed protein, golden rice</p> <p>Livestock: Transgenic Animal: Mice, Rabbit, Cattle, Goat, Sheep, Pigs & Fish, animals</p> <p>Human welfare: Cloned genes for production of -Insulin; recombinant vaccine for Hepatitis B virus. Molecular farming, Edible vaccines and their advantages Environment</p> <p>Case study: GMOs Pros and Cons</p>		<p>15</p>
<p>UNIT III Rules and Regulations in Biotechnology</p>	<p>Biosafety- Introduction, Risk assessment- Assessment of risk during laboratory research, Risk assessment of biotechnology products; Containment – physical and biological containment; Planned introduction of GMOs; Biosafety during industrial production using GMO's ; Biosafety guidelines in India.</p> <p>Intellectual Property Right (IPR) and Protection (IPP) - Forms of protection- Patents, Copy rights, Trade secret, Trademarks, Plant variety protections. Patenting of biological material, significance of patent in India.</p> <p>The World Intellectual Property Organization (WIPO), General Agreement on Tariffs and Trade (GATT), Trade related IPRs (TRIP's) Patent status International scenario.</p>		<p>15</p>
<p>References</p> <ol style="list-style-type: none"> 1. Dubey, R. C. (1993). A textbook of Biotechnology. S. Chand Publishing. 2. Dubey, R. C. (2014). Advanced biotechnology. S. Chand Publishing. 3. Singh, B. D., & Singh, B. D. (2007). Biotechnology expanding horizons. Kalyani publishers. 			

SEMESTER-I
Paper-II Basics of Microbiology (UBT1BOM)

Course Objective: To build a firm foundation in microbiology, sterilization techniques and staining.			
Learning Outcome: By the end of the course the student will: <ul style="list-style-type: none"> • Build skill towards use of microscopy and staining techniques. • Explain the concepts of sterilization and the mechanism of disinfection. • Categorize different types of microorganisms based on their nutritional requirements. • Apply different methods and techniques for growth and enumeration of microorganisms. 			
Unit	Title	Credits	Lectures
UNIT I Introduction to Microbiology	Fundamentals, History and Evolution of Microbiology: Discovery of Microorganisms, Conflict over spontaneous generation. Role of microorganisms in disease Classification: The place of Microorganisms in the living world, Classification Whittaker's five kingdom classification, Introduction to Bergey's Manual, Groups of Microorganisms, Applications of microbiology in various fields Nutrition, Cultivation and Maintenance of microorganisms: Nutritional categories of microorganisms, Design and Types of Culture Media, methods of isolation.(Pure Culture Techniques- Streak plate, Pour, Spread plate, Tube dilution)	2	15
UNIT II Sterilization Techniques	Introduction: Definition and concept of Sterilization and Disinfection. Types and Applications: Dry Heat, Steam under pressure Gases, Radiation and Filtration Chemical Agents and their Mode of Action: Aldehydes, Halogens, Quaternary Ammonium Compounds, Phenol and Phenolic Compounds, Heavy Metals, Alcohol, Dyes, and Detergents.		15

	Disinfectant: Ideal Disinfectant. Examples of Disinfectants and Evaluation of Disinfectant (Tube dilution & Agar plate techniques, Phenol coefficient , Tissue toxicity index)		
UNIT III Microscopy and stains	<p>Simple and Compound Microscope: General principles of optics; various parts and their functions - objectives – numerical aperture, resolving power, depth of focus, working distance, aberrations; oculars; condensers.</p> <p>Principle, working and applications of Dark Field Microscope; Phase Contrast Microscope, Fluorescent Microscope, TEM and SEM</p> <p>Stains and Staining Solutions- Definition of Dye and Chromogen; acidic and basic dyes; functions and types of chromophore and auxochrome groups. Definition and function of stain; mordant, intensifiers and Fixative.</p> <p>Simple, negative, differential staining and special staining.</p>		15
<p>References:</p> <ol style="list-style-type: none"> 1. Prescott, L. M. (2002). Microbiology 5th Edition. 2. Prescott, L. M. (2015). Microbiology 10th Edition. 3. Pelczar, Microbiology. (1993). India: McGraw-Hill Education. 4. Ananthanarayan, R., Paniker, C. J. (2006). 5. Ananthanarayan and Paniker's Textbook of Microbiology. India: Orient Longman. 6. Salle, A. J., & A. J. Salle (1954). Fundamental principles of bacteriology McGraw-Hill. 7. Frobisher M. Fundamentals of Microbiology (9th Ed) 			

SEMESTER-I
Paper-III Basic Chemistry-I (UBT1BCH)

Course Objective: To acquaint the students with basic concepts of Chemistry like Chemical bonds, Titrimetry, Gravimetry, Stereochemistry Isomerism.			
Learning Outcome: By the end of the course the student will able to:			
<ul style="list-style-type: none"> ● Explain chemical bonds. ● Develop skills towards use of titrimetric and gravimetric analysis. ● Differentiate between chiral and achiral molecules and different enantiomers. ● Illustrate of different types of chemical formulas. 			
Unit	Title	Credits	Lectures
UNIT I Chemical bonds	<p>Chemical Bonds: Types and transition between the main types of bonding.</p> <p>Ionic Bond: Nature of Ionic Bond, factors influencing the formation of Ionic Bond. Structure of NaCl and CsCl.</p> <p>Covalent Bond: Nature of Covalent Bond, Types of covalent bond (Polar and Coordinate. covalent bonds). Structure of CH₄, NH₃, Shapes of BeCl₂, BF₃.</p> <p>Hydrogen Bond: Theory of Hydrogen Bonding and Types of Hydrogen Bonding (with examples of RCOOH, ROH, Salicylaldehyde, Amides and Polyamides)</p> <p>Interactions stabilizing biomolecules – Hydrophobic Interactions, Dipole-Dipole Interactions, Van der Waals interactions and Disulfide bonds</p>	2	15
UNIT II Titrimetry and Gravimetry	<p>Titrimetric Analysis: Titration, Titrant, Titrand, End Point, Equivalence Point, Titration Error, Indicator, Primary and Secondary Standards, Characteristics and examples.</p> <p>Types of Titrations – Acid -Base, Redox, Precipitation, Complexometric Titration.</p> <p>Acid – Base Titration – Strong Acid Vs Strong Base. Theoretical aspects of Titration Curve and</p>		15

	<p>End Point Evaluation. Theory of Acid –Base Indicators, Choice and Suitability of Indicators.</p> <p>Gravimetric Analysis: Solubility and Precipitation, Factors affecting Solubility, Nucleation, Particle Size, Crystal Growth, Colloidal State, Ageing/Digestion of Precipitate. Co-Precipitation and Post-Precipitation. Washing, Drying and Ignition of Precipitate.</p>		
<p>UNIT III Stereochemistry Isomerism</p>	<p>Types of Isomerism: Structural Isomerism and Stereoisomerism with Suitable examples.</p> <p>Geometric Isomerism and Optical Isomerism: Enantiomers, Diastereomers, and Racemic mixtures Cis-Trans, Threo, Erythro and Meso isomers. Diastereomers (Cis-Trans Isomerism) in Alkenes.</p> <p>Conformation: Conformations of Ethane. Difference between Configuration and Conformation.</p> <p>Configuration: Asymmetric Carbon Atom, Stereogenic/ Chiral Centers, Chirality Representation of Configuration by –Flying Wedge Formula</p> <p>Projection formulae: Fischer, Newman and Sawhorse. The Interconversion of the Formulae. E, Z System of Nomenclature-Rules and Examples</p>		<p>15</p>
<p>Referencing:</p> <ol style="list-style-type: none"> 1. Bahl, B. S., & Bahl, A. (2017). A textbook of organic chemistry. S. Chand Publishing. 2. Lee, J. D. (2008). Concise inorganic chemistry. John Wiley & Sons. 3. Skoog, D. A., West, D. M., Holler, F. J., & Crouch, S. R. (2013). Fundamentals of analytical chemistry. Cengage learning. 4. Vogel, A. I., & Jeffery, G. H. (1989). Vogel's textbook of quantitative chemical analysis. Wiley. 5. Mosher, M. (1992). Organic Chemistry. (Morrison, Robert Thornton; Boyd, Robert Neilson) 			

SEMESTER-I
Paper-IV Biochemistry-I (UBT1BOC)

Course Objectives: To acquaint the students with different concepts of biomolecules.			
Learning Outcomes: By the end of the course the student will:			
<ol style="list-style-type: none"> 1. Discuss the chemistry of carbohydrates with their roles. 2. Explain Classification and general properties of Proteins. 3. Elaborate protein structure and function. 4. Understand structure and functions of Nucleic acids 			
Unit	Title	Credits	Lectures
UNIT I Basics of Carbohydrate Chemistry	<p>Carbohydrates: Introduction, definition and general formula. Classification of carbohydrates:</p> <p>Monosaccharides: Classification, Chemical reactions and significance of Monosaccharides, Epimers, Anomers and Mutarotation. Biologically important Derivatives of Hexoses: Glucosamine, Gluconic acid, uronic acid, N-acetyl glucosamine, N-Acetylmuramic acid</p> <p>Disaccharides: Maltose, Lactose, Sucrose, Cellobiose (structures, Reducing and Non reducing sugars biological significance, structure and bond type)</p> <p>Polysaccharides: Homo-polysaccharides and Hetero-polysaccharides; Structure and Storage Polysaccharides. Industrial applications of carbohydrates.</p>	2	15
UNIT II Amino acids and Proteins	<p>Amino acids: General introduction, Classification and structures, properties (physical chemical). Isomerism. Titration Curve of Amino Acids. Concept of Isoelectric pH, Zwitterion Reactions of Amino Acids: Sorenson's Titration, Ninhydrin Test.</p> <p>Classification of Proteins: Simple- Fibrous and Globular Conjugated- Nucleoprotein, Lipoprotein, Glycoprotein, Phosphoprotein, Chromoprotein, Metalloprotein Derived- Primary and Secondary</p>		

	<p>Peptide bond: Features Example of Dipeptide, tripeptide, Nonapeptide e.g., Oxytocin, Vasopressin Amino acid composition of Bovine Cytochrome C and Bovine Chymotrypsinogen</p> <p>Three-dimensional Structure of proteins: Concept of Monomeric, dimeric and multimeric proteins, Primary structure - Peptide linkage, Native Secondary structure - Alpha Pleat and Beta fold; Spatial arrangements of adjacent amino acid residues Tertiary structure - Three-Dimensional arrangement Quaternary structure Di and Multimeric proteins E.g., structure of human Insulin</p> <p>Properties of proteins: Solubility, Molecular weight, Shape, Iso electric pH, Salting out of proteins for purification</p> <p>Protein Denaturation and folding: Denaturing agents and properties of denatured proteins.</p>		
<p>UNIT III Nucleic acids</p>	<p>The Composition and structure of DNA and RNA: Structure, Function of Nucleic Acids, Properties and Types of DNA, RNA. Structure of Purine and Pyrimidine Bases Hydrogen Bonding between Nitrogenous Bases in DNA. Structure of Nucleosides, Nucleotides and Polynucleotides. Watson and Crick's Model. DNA Denaturation.</p> <p>Structure of RNA. Types of RNA. Differences between DNA and RNA. Difference between A, B and Z forms of DNA</p>		<p>15</p>
<p>References :</p> <ol style="list-style-type: none"> 1. Stryer, L. (2015). Biochemistry. (8th edition) New York: Freeman. 2. Lehninger, A. L. (2017). Principles of Biochemistry (7th edition). New York, NY: W 3. Voet, D., & Voet, J. G. (2018). Biochemistry (5th edition). Hoboken, NJ: J. Wiley & Sons. 4. Cox, M. M., & Nelson, D. L. (2017). Lehninger principles of biochemistry (Vol. 7). New York: Wh Freeman. 5. Conn, E., & Stumpf, P. (2009). Outlines of biochemistry. John Wiley & Sons. 6. Satyanarayana U. and Chakrapani U. (2007). Biochemistry. 3rd Edition. Books and Allied (P) Ltd. 7. Mu, P., & Plummer, D. T. (2001). Introduction to practical biochemistry. Tata McGraw-Hill Educatio 			

SEMESTER-I
Paper-V Cell Biology (UBT1CBI)

Course Objective: To build a firm foundation of concepts related to cell biology			
Learning Outcome: By the end of the course the student will:			
<ul style="list-style-type: none"> • Discuss the ultrastructure, function and location of organelles in prokaryotic and eukaryotic cells • Illustrate the principles of membrane transport with different types of pumps and cell junctions. • Compare different phases of cell cycle along with roles of restriction points and checkpoints • Define the role of apoptosis in maintenance and development of healthy cells. 			
Unit	Title	Credits	Lectures
UNIT I 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, Pili, Cell Wall (Gram Positive and Negative), Cell Membrane, Cytoplasm and Genetic Material Storage Bodies and Spores	2	15
	Ultra-structure of Eukaryotic Cell: Plasma membrane, Cytoplasmic Matrix, Microfilaments, Intermediate Filaments, and Microtubules Organelles of the Biosynthetic-Endoplasmic Reticulum & Golgi apparatus. Lysosome, Eukaryotic Ribosomes, Mitochondria, and Chloroplasts. Nucleus –Nuclear Structure, Nucleolus Cilia and Flagella Comparison of Prokaryotic and Eukaryotic Cells.		
UNIT II Cell membrane	Membrane Structure and Function- Chemical composition of membranes, Membrane lipids; Membrane proteins Functions of membranes: Transport, Cell-cell interactions, Receptors. Membrane Model: Fluid Mosaic Model Membrane transport: Active Transport, Passive Transport, Diffusion and Osmosis, Membrane		15

	<p>transport associated disease e.g. cystic fibrosis. Bulk transport: endocytosis and exocytosis Membrane junctions Classification of junctions: Occluding: Tight, Anchoring: Desmosomes, Channel- forming: Gap, Plasmodesmata. Cell Coat and Cell Recognition.</p>		
<p>UNIT III Cell cycle</p>	<p>Cell cycle, cell division and cell death Cycle in Prokaryotic and Eukaryotic cell (G0, G1, G2, M phases)Cell cycle phases, Control of mitosis by cyclins, MPF activity and cyclin-dependent kinases, checkpoints in cell cycle regulation</p> <p>Mitosis and Meiosis and their significance; Eukaryotic cell division</p> <p>Programmed Cell Death- Introduction to Apoptosis, Apoptosis pathways and its regulation; Difference in Apoptosis and Necrosis.</p>		<p>15</p>
<p>References:</p> <ol style="list-style-type: none"> 1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2008). Molecular Biology of the Cell (5th Ed.). New York: Garland Science. 2. Lodish, H. F. (2016). Molecular Cell Biology (8th Ed.). New York: W.H. Freeman. 3. Cooper, G. M., & Hausman, R. E. (2013). The Cell: a Molecular Approach (6th Ed.). Washington: ASM; Sunderland. 4. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc. 5. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition.Lippincott Williams and Wilkins, Philadelphia. 			

SEMESTER-I
Paper-VI Genetics (UBT1GEN)

Course Objective: To provide insight to students on fundamental concepts of mendelian genetics, microbial genetics and cytogenetics.			
Learning Outcome: By the end of the course the student will able to: <ul style="list-style-type: none"> • Compare different mechanisms of Genetic Exchange in Bacteria. • Illustrate Incomplete dominance, codominance and multiple alleles. • Explain the organization of Eukaryotic Genetic Material, in Chromosomal aberrations and Sex Determination Interpret the Mendel's Principle in Human Genetics			
Unit	Title	Credits	Lectures
UNIT I Genetics Fundamentals	<p>Introduction to genetic and sub-disciplines of genetics: Transmission genetics, Molecular genetics, Population genetics and Quantitative genetics.</p> <p>Basic Terminologies in genetics</p> <p>Mendelian Genetics: Monohybrid Crosses and Mendel's Principle of Segregation Dihybrid crosses and Mendel's Principle of Independent Assortment.</p> <p>Extensions of and Deviations from Mendelian Genetic Principles: Multiple Alleles - ABO Blood groups Modifications of Dominance Relationships: Incomplete Dominance and Co-dominance. Environmental effect on the expression of the Human Genes.</p> <p>Gene Interactions and Modified Mendelian Ratios- Epistatic and non-epistatic interactions Essential Genes and Lethal Alleles</p>	2	15
UNIT II Cytogenetics	<p>Structure and organization of eukaryotic genetic material – Histone and non-histone proteins, nucleosome structure. Heterochromatin, Euchromatin, Polytene Chromosomes, Lampbrush chromosome.</p> <p>Chromosomal banding techniques Karyotype and Idiogram</p>		15

	<p>Variation in Chromosomal Structure and Number: Deletion, Duplication, Inversion, Translocation, Aneuploidy, Euploidy and Polyploidy and Syndromes- Klinefelter, Turner, Cri-du-Chat, Trisomy-21, Trisomy-18 and Trisomy-13.</p> <p>Sex Determination and Sex Linkage: Mechanisms of Sex Determination (XX-XY, ZZ-ZW, XX-XO)</p> <p>Dosage Compensation and Barr Body.</p>		
UNIT III Microbial Genetics	<p>Genetic analysis in Bacteria- Prototrophs, Auxotrophs.</p> <p>Bacteriophages: Lytic and Lysogenic development of Phage.</p> <p>Mechanism of Genetic Exchange in Bacteria: Conjugation; Transformation; Transduction (Generalized Transduction, Specialized Transduction);</p> <p>Bacterial Transposable Elements.</p>		15
<ol style="list-style-type: none"> 1. Russell, P. J., & Gordey, K. (2002). I Genetics, San Francisco: Benjamin Cummings. 2. Verma, P. S., & Agarwal, V. K. (2004). Cell Biology, Genetics, Molecular Biology, 13 Evolution and Ecology: Evolution and Ecology. S. Chand Publishing. 3. Simmons, M. J., & Snustad, D. P. (2006). Principles of genetics. John Wiley & Sons. 4. Russell, P. J. (2000). Fundamentals of genetics. Longman Publishing Group. 5. Karp, G. (2009). Cell and molecular biology: concepts and experiments. John Wiley & Sons. 6. Strickberger M., Genetics. (1995). Australia: Deakin University. 			

SEMESTER-I

Paper-VII Environmental Science and Sustainable Development (UBT 1ESS)

Course Objectives: To sensitize and create awareness about Ecology, renewable energy and different Environmental Issues.			
Learning Outcomes: By the end of the course the student will: <ul style="list-style-type: none"> • Develop an understanding of the structure and functioning of the ecosystems. • Gain insights about the concept of pollution, climate change and sustainable development • Understand the relevance of renewable energy sources and conservation of biodiversity • Understand the relevance of conservation of biodiversity 			
Unit	Title	Credits	Lectures
UNIT I Ecological interactions and Biodiversity	<p>Concept of Ecosystems: Definition and Components- Structure and function of ecosystem aspects of ecosystems Food Chain and Food Web, Ecological Pyramids (Energy, Biomass and Number) Aquatic and Terrestrial Ecosystems, Different Abiotic Factors of ecosystem and adaptations to different abiotic factors</p> <p>Ecological Interactions: Commensalism, Mutualism, Predation and Antibiosis, Parasitism, competition</p> <p>Biodiversity and its conservation: Introduction – definition: genetic, species, ecosystem diversity, biogeographic classification of India, value of biodiversity, biodiversity at global, national and local levels, India as a mega diversity nation, Hotspots of biodiversity, threats to biodiversity, conservation of biodiversity</p>	2	15
UNIT II Pollution and climate change	<p>Environmental Pollution: Definition, Cause, effects and control measures of- Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, nuclear hazards. Role of an individual in prevention of pollution. Pollution case studies.</p> <p>Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust.</p>		15

	<p>Sustainable development: Concept, basic principles of sustainable development, post-brundtland world, roots of sustainability, Indicators, paradigm towards new discipline-sustainability science.</p>		
<p>UNIT III Renewable sources of energy</p>	<p>Introduction: Renewable and Non-renewable resources. The need for a sustainable lifestyle. Energy resources: Types of energy Non- renewable energy - Oil, coal and its environmental impacts. Renewable energy: Hydroelectric power, Solar energy, Biomass energy, Biogas, Wind power and Geothermal energy. Biogas technology: Biogas plant & types, biodigester. Biogas- composition, production and factors affecting production and uses. Biofuels: Ethanol production, Microbial hydrogen production, Biodiesel, Petrocrops.</p>		<p>15</p>
<p>References :</p> <ol style="list-style-type: none"> 1. Verma, V. (2010). Botany. India: Ane Books Pvt Ltd. 1. Bharucha, E. (2005). Textbook of Environmental Studies for Undergraduate Courses. India: Universities Press (India) Pvt. Limited. 2. Verma, P. S. (2004). Cell Biology, Genetics, Molecular Biology: Evolution and Ecology. India: S. Chand Limited. 3. Khoiyangbam, R. S. (2015). Introduction to Environmental Sciences. India: Energy and Resources Institute. 4. Fulekar, M. H. (2010). Environmental Biotechnology. United Kingdom: CRC Press. 5. Scragg, A. H. (2004). Environmental Biotechnology. United Kingdom: Oxford University Press 			

SEMESTER-I
Paper-VIII Computer Applications in Biotechnology (UBT1CAB)

Course Objectives: To develop the students' understanding of computers.			
Learning Outcomes: By the end of the course the student will:			
<ul style="list-style-type: none"> • Develop an understanding of computer networking and internet • Develop skills to use word processing, spreadsheet, and presentation software. • Develop skills to present biological data. 			
Unit	Title	Credits	Lectures
UNIT I Introduction to computers	<p>Overview and functions of a computer system Input and output devices, Storage devices.</p> <p>Modern computers: The workstation, The Minicomputer, Mainframe Computers, Parallel processing Computer Super Computer.</p> <p>Introduction to operating systems: Operating System concept, Windows, Unix / Linux & servers.</p> <p>Word Processing: Basic Operations, Creating and Editing documents, Formatting documents.</p> <p>Spreadsheet: Creating and editing workbook, organizing and formatting worksheets; Data analysis and management; Using formulas and functions</p> <p>Presentation Graphics: Creating and Editing Presentations, Designing and Enhancing Presentation, Delivering Presentation, Advanced Presentation Graphics.</p>	2	15
UNIT II Computer networking	<p>Introduction to networking and Internet: Various terminologies Associated hardware devices, gadgets (Router, Switch) tools, services, and resources Network Topologies and Protocols, LAN, WAN and MAN, World Wide Web (WWW),</p> <p>Network security: fire walls</p> <p>Internet:-Introduction, History of Internet, Internetworking Protocol,</p> <p>Email:-E-mail Address, E-mail Message Format, E-mail Services, How E-mail Works File Transfer Protocol (FTP), How FTP Works?</p> <p>Computer viruses: An overview of Computer viruses: What is a virus? Virus signs, how do they</p>		15

	<p>get transmitted? What are the dangers? General Precautions.</p> <p>Introduction to R: Data input, Arithmetic Operators, Vector Operations, Matrix Operations, Data Frames, Built-in Functions. Frequency Distribution, Grouped Frequency Distribution, Diagrams and Graphs, Summary statistics for raw data and grouped frequency distribution.</p>		
<p>References:</p> <ol style="list-style-type: none"> 1. Sinha, P. K., Sinha, P. (2004). Computer Fundamentals. India: BPB Publications. 2. Goel, A. (2010). Computer Fundamentals. India: Pearson Education. 3. Wempen, F. (2014). Computing Fundamentals: Introduction to Computers. Germany: Wiley. 4. Tanenbaum, A. S., Wetherall, D. (2014). Computer Networks. United Kingdom: Pearson Education. 5. Khanal, A. B. (2015). 			

F.Y. B.Sc. Biotechnology
Semester -I
PRACTICALS

Course Code	Title	Credits
UBT1PR1 Practical of UBT1BIT & UBT1BOM	<ol style="list-style-type: none"> 1. Assignment on any one branch of Biotechnology. 2. Analyze a case-study and write a report on any one recent application of Biotechnology (Not older than past 5 years) 3. Field visit/ Virtual visit (website) of National/ International research institutes for research in biotechnology and have a group discussion during the lab session. 4. Study of Microscope – Compound Microscope (Including Handling and storage), Dark Field Microscope, Phase Contrast Microscope, Fluorescent Microscope, TEM, SEM. 5. Monochrome staining using any suitable material. (Bacteria/Plant/Animal tissue) 6. Negative staining 7. Differential staining – <ol style="list-style-type: none"> a. Gram staining, b. Acid fast staining, 8. Romanowsky staining. 9. Special staining – <ol style="list-style-type: none"> a. Cell wall b. Capsule c. Spores 10. Fungal staining – Wet mount (Lactophenol cotton blue/Methylene Blue) 11. Preparation of media- Nutrient broth and Agar, MacConkey Agar, Sabouraud's Agar 12. Sterilization of Laboratory Glassware and Media using Autoclave and Hot air oven 13. Aseptic transfer technique (tube to tube, tube to plate, pipette to tube). 14. Isolation techniques: T-streak, polygon method 15. Colony Characteristics of Microorganisms. 16. Qualitative Assay of enzyme urease, amylase, dehydrogenase, catalase and protease from Plant/Animal/Microbial source. 17. Use of Bergey's manual to help identify any one isolate 	2

<p>UBT1PR2 Practical of UBT1BCH & UBT1BOC</p>	<ol style="list-style-type: none"> 1. Safety in Chemistry Laboratory: Dress code, Dos and Don't, First Aid 2. Preparation of Normal, Molar, Molal, Percent solution 3. Preparation of solution - PPM and PPB 4. Determine the rate constant for the saponification reaction between ethyl acetate and NaOH by back titration method 5. Determination of Acetic acid in Vinegar by Titrimetric Method. 6. Determination of the amount of Fe (II) present in the given solution titrimetrically. 7. Determination of amount of NaHCO₃ + Na₂CO₃ in the given solid mixture titrimetrically. 8. Determination of the amount of Mg (II) present in the given solution complexometrically. 9. Determination of percent composition of BaSO₄ and NH₄Cl in the given mixture gravimetrically. 10. Characterization of Organic Compounds any three organic compounds 11. Structures of Aldo series and Keto series of Monosaccharides, disaccharides and Polysaccharides 12. Qualitative tests for carbohydrates; Molisch test, Benedict's test, Iodine test, Osazone formation 13. Estimation of carbohydrates by Lane-Eynon method 14. Tutorial: Structure of Amino acids. 15. Titration curve of amino acid. 16. Qualitative analysis of amino acids and proteins. 17. Separation by Paper Chromatography a. Amino acids b. Sugars. 18. Estimation of Protein by Biuret method. 19. Study of Watson and Crick model of DNA using micrographs/ Schematic representations. 20. Qualitative analysis of DNA and RNA. 21. Extraction of DNA from suitable material. 22. Assignment - Practice problems on stereochemistry (Identifying - stereoisomers, conformations of specific compounds, chirality and symmetry elements; drawing stereoisomers; locating and naming stereogenic centers) 	<p style="text-align: center;">2</p>
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<p>UBT1PR3 Practical of UBT1CBI & UBT1GEN</p>	<ol style="list-style-type: none"> 1. Study of mitosis from suitable plant material 2. Study of meiosis from suitable plant material/Permanent slides/Photographs 3. Study of mitosis using pre-treated root tips of Allium cepa to study the effect of mutagens- chemical (colchicine/ PDB) on mitosis 4. Problems based on Mendelian Genetics, its modifications and gene interactions. 5. Study of Karyotype - Normal and abnormal 6. Barr body identification in cells of Buccal smear 7. Preparation of competent cells and demonstration of Bacterial transformation and mapping 8. Demonstration of Bacterial Conjugation and interrupted mating-based mapping 9. Demonstration of transduction and mapping 10. Conduct a survey on observable genetic traits and compare those inventories with other students in groups. (Blood group, tongue rolling, earlobe attachment, PTC tasting etc.) 11. Study of blood groups ABO in humans 	<p>2</p>
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SEMESTER-II THEORY

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SEMESTER-II
Paper-I Biotechnology- II (UBT2BIT)

Course Objectives: To acquaint students with the applications of biotechnology in the field of food, medicine and fermentation			
Learning Outcomes: By the end of the course the student will: <ul style="list-style-type: none"> • Explain the basic principles of PTC and callus culture. • Develop an understanding of the application of biotechnology in the food industry. • Gain insight into details of genetic engineering. • Discuss tools and techniques used in medical biotechnology 			
Unit	Title	Credits	Lectures
UNIT I Plant Tissue Culture	<p>Concept of Cell Culture, Cellular Totipotency.</p> <p>Organization of Plant Tissue Culture</p> <p>Laboratory: Equipment's and Instruments</p> <p>Aseptic Techniques: Washing of Glassware, Media Sterilization, Aseptic Workstation, Precautions to maintain Aseptic Conditions.</p> <p>Culture Medium: Nutritional requirements of the explants, PGR's and their in-vitro roles, Media Preparation.</p> <p>Callus Culture Technique: Introduction, Principle, Protocols and Applications.</p>	2	15
UNIT II Food Biotechnology	<p>Introduction to food biotechnology:</p> <p>History of microorganisms in food science and key developments, Applications of biotechnology in fermented food products</p> <p>Introduction to Unit Operations and Processes:</p> <p>Basic unit operations, food processing & packaging (canning & bottling), Production of cultures</p> <p>Fermented food products:</p> <p>Bread, Vinegar, Sauerkraut, Single Cell Protein (SCP), Probiotics.</p> <p>Food spoilage, food deterioration, food contamination and Food Adulteration</p> <p>Methods of food preservation</p> <p>Indicators of Food Microbial Quality & Safety: HACCP, FSSAI & FDA</p>		15

<p>Unit-III Applications of Microbes in Biotechnology</p>	<p>Microbiology of Fermented Foods: Fermented Milks, Chocolates, Cheese Production, Meat, Fish, Wines and Champagne & Beers, Ales, Distilled Spirit and Breads.</p> <p>Microbes as a source of Products of Industrial Importance-Antibiotics, amino acids, Organic Acids, Biosurfactants, Biopolymers and Vaccines</p> <p>Microbial energy conversion-Biofuel</p> <p>Microbes in agriculture Biotechnology- Bio insecticides and bio pesticides.</p> <p>Roles of microbes in Environmental Biotechnology-Microbial Fuel Cells: Batteries Powered by Microbes. Biodegradation and Bioremediation Harness Microbes to Clean the Environment.</p>		<p>15</p>
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References

1. K.K. De Plant tissue culture.
2. Bhojwani and Razdan plant tissue culture, Elsevier.
3. Frazier, W. C., & Westhoff, D. C. (1983). Food microbiology 5th Ed. 2. Lee, B. H. (2014).
4. Fundamentals of food biotechnology. John Wiley & Sons.
5. Jay, J. M., Loessner, M. J., & Golden, D. A. (2008). Modern food microbiology. Springer Science & Business Media. 4. Woolverton, C. J., Sherwood, L., Willey, J. (2014).
6. Prescott's Microbiology. India: McGraw-Hill Education.
7. Patel, A. H. (1984). Industrial Microbiology. Macmillan India. 6. Khan, F. A. (2011). Biotechnology fundamentals. CRC Press

SEMESTER-II
Paper-II Microbiology and Immunology (UBT2MAI)

Course Objective: To build a firm foundation of concepts related to Microbiology and Immunology.			
Learning Outcome: By the end of the course the student will:			
<ul style="list-style-type: none"> ● Compare replication mechanisms used by viruses along with their cultivation, purification techniques ● Apply different methods and techniques for growth and enumeration of microorganisms. ● Elaborate the concept of Immunity and role of antigens and immunoglobulin in the immune system. ● Explain the Humoral and Cellular Immune Response 			
Unit	Title	Credits	Lectures
UNIT I Virology	Introduction to virology: Historical perspective, General Characteristics of Viruses: Host Range Viral Structure: Nucleic Acid, Capsid and Envelope General Morphology- Helical, Polyhedral, Enveloped, Complex. Taxonomy of Viruses Viral Multiplication: Multiplication of Bacteriophages and Animal Viruses Isolation, Cultivation, and Identification of Viruses: Growing Bacteriophages and animal viruses in the Laboratory, Viral Identification Case studies- TMV, Influenza COVID-19	2	15
UNIT II Microbial Growth	Definition of Growth Mathematical and expression of growth Growth curve Measurement of growth Efficiency of growth yield ,Synchronous growth Factors influencing microbial growth: oxygen, temp., pH, salt etc. Batch Culture Continuous Culture of microorganisms Chemostat and Turbidostat Enumeration of Microorganisms: Direct and Indirect Methods Preservation and Maintenance of cultures, Culture Depositories		15

<p>UNIT III Immunology</p>	<p>Introduction to Immunology: Overview of Immune Systems: Innate Immunity, Mechanisms of innate immunity, Acquired Immunity, Local and Herd Immunity, Humoral and Cellular Immunity - Factors Influencing and Mechanisms of each.</p> <p>Antigens: Immunogenicity Versus Antigenicity, Factors That Influence Immunogenicity, Epitopes, Haptens, Superantigens</p> <p>Antibodies: Basic Structure of Antibodies, Antibody-Mediated Effector Functions, Antibody Classes and Biological Activities, Antigenic Determinants on Immunoglobulins. Monoclonal Antibodies Introduction to vaccination</p>		<p>15</p>
<p>References :</p> <ol style="list-style-type: none"> 1. Pelczar, Microbiology. (1993). India: McGraw-Hill Education. 2. Stanier, R. Y. (1987). General Microbiology. Hong Kong: Macmillan. 3. Funke, B. R., Case, C. L., Tortora, G. J. (2013). Microbiology: An Introduction. United Kingdom: Pearson. 4. Woolverton, C. J., Sherwood, L., Willey, J. (2014). Prescott's Microbiology. India: McGraw-Hill Education 5. Goldsby, U. R. A., Kuby, J., Kindt, T. J., Goldsby, R. A., Osborne, B. A., Marcus, D. A. (2003). Immunology. United Kingdom: W. H. Freeman. 6. Rao, C. V. (2017). Immunology. United Kingdom: Alpha Science International, Limited. 			

SEMESTER-II
Paper-III Basic Chemistry- II (UBT2BCH)

Course Objective: To acquaint the students with some core concepts of Physical Chemistry.			
Learning Outcome: By the end of the course the student will:			
<ul style="list-style-type: none"> • Develop an understanding of thermodynamics. • Learn about reaction kinetics and order of reaction. • Gain insight into the details of reaction mechanisms in Organic Chemistry. 			
Unit	Title	Credits	Lectures
UNIT I Thermodynamics	<p>Thermodynamics: System, Surrounding, Boundaries Sign Conventions, State Functions, Internal Energy and Enthalpy: Significance, examples, (Numericals expected.)</p> <p>Laws of Thermodynamics and its Limitations:</p> <p>Mathematical expression. Qualitative discussion of Carnot Cycle for ideal Gas and Mechanical Efficiency.</p> <p>Laws of Thermodynamics as applied to Biochemical Systems.</p> <p>Concept of Entropy, Entropy for Isobaric, Isochoric and Isothermal Processes.</p> <p>Thermodynamics of ATP; Helmholtz</p>	2	15
UNIT II Chemical Kinetics	<p>Reaction Kinetics:</p> <p>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).</p> <p>Determination of Order of Reaction:</p> <ol style="list-style-type: none"> a) Integration Method b) Graphical Method c) Ostwald's Isolation Method d) Half Time Method. 		15
UNIT III Reaction Mechanisms in Organic Chemistry	<p>Review of organic reaction mechanisms with special reference to</p> <p>Nucleophilic and electrophilic substitution (SN1, SN2, SNi, SE 1, SE2) Reactions.</p> <p>Elimination (E1 and E2) Reactions.</p> <p>Addition reactions- (regioselectivity: Markovnikov's addition-carbocation</p>		15

	mechanism, anti- Markovnikov's addition-radical mechanism). Oxidation Reduction reactions: Principles of Oxidation & Reduction Reactions: Oxidizing and Reducing Agents.		
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References

1. Rao, C. N. R. (1973). University General Chemistry: An Introduction To Chemical Science. India: Macmillan India Limited.
2. Chang, R. (2000). Physical Chemistry for the Chemical and Biological Sciences. United Kingdom: University Science Books.
3. Lee, J.D., Concise Inorganic Chemistry, 5TH ED. (2008). India: Wiley India Pvt. Limited.
4. Bajpai, D. N. (2001). Advanced Physical Chemistry. India: S. Chand, Limited.
5. Singh, A. K., Singh, N. B., Das, S. S. (2009). Physical Chemistry: Volume II. India: New Age International

SEMESTER-II
Paper-IV Bioorganic Chemistry- II (UBT2BOC)

Course Objective: To build a firm foundation on the fundamentals of Bioorganic Chemistry and analytical techniques			
Learning Outcome: By the end of the course the student will: <ul style="list-style-type: none"> • Discuss the basics of lipid biochemistry. • Illustrate structure, functions and applications of enzymes. • Develop skills towards the principle, working and applications of different analytical techniques. 			
Unit	Title	Credits	Lectures
Unit I Basics of Lipid Chemistry	Definition and Biological functions of fats and Lipids. Definition of Fatty acids. Sources, Cis-trans forms Classification of Fatty acids: Saturated Fatty Acids, Unsaturated Fatty Acids: Definition of MUFA and PUFA. C16- C20. Palmitoleic acid, Oleic, Linoleic, Lenolenic, Arachidonic acid Storage Lipids: AcylGlycerols, Types and properties of Triacylglycerols: Hydrolysis, Saponification, Antioxidant, Rancidity, Acid number, RM number, Action of lipase. Structural lipids: Phospholipids, Cardiolipin Action of Phospholipase Sterols: Structure and functions Eg: Cholesterol	2	15
UNIT II Enzymes	Introduction to biocatalysis: Properties of Enzymes Substrate, Optimum conditions, Co-substrate, Coenzyme, Cofactors Classification and Nomenclature (one reaction per Class) Mechanism of Enzyme Action, Active Sites, Enzyme Specificity, Factors affecting enzyme activity (Effect of pH, Temperature, Substrate Concentration, Enzyme concentration) Enzyme Kinetics: Derivation of Michaelis-Menten Equation, Lineweaver-Burk plot, Concept of Km Types of Enzyme Inhibitions: Irreversible & Reversible (Competitive, Uncompetitive, Non-Competitive)		15

	Isoenzymes Allosteric Modulators, Co-Factors, Zymogens, Enzyme units Oxidizing and Reducing Agents.		
UNIT III Basics of Analytical techniques	Methods of Separation: Precipitation, Filtration, Distillation and Solvent Extraction Chromatography: Definition, Principles, and applications of Paper Chromatography, Thin Layer Chromatography, Column Chromatography Spectroscopy, Colorimetry: Properties of electromagnetic radiation, interaction with matter, lasers Colorimetric assays - Principle, Beer-Lambert's Law, Limitations of Beer-Lambert's Law, Electrophoresis: General principles, Factors affecting electrophoresis, Types of support media used, Types of electrophoresis (Agarose gel electrophoresis, PAGE): Oxidizing and Reducing Agents.		15

References

1. Cox, M. M., & Nelson, D. L. (2008). Lehninger principles of biochemistry (Vol. 5). New York: Wh Freeman.
2. Conn, E., & Stumpf, P. (2009). Outlines of biochemistry. John Wiley & Sons.
3. Satyanarayana U. and Chakrapani U. (2007). Biochemistry. 3rd Edition. Books and Allied (P) Ltd.
4. Plummer, D. T. (2001). Introduction to practical biochemistry. Tata McGraw-Hill Education.
5. Jain, J. L. (2004). Fundamentals of Biochemistry. India: S. Chand Limited.
6. Skoog, D. A., West, D. M., Holler, F. J., Crouch, S. R. (2014). Fundamentals of Analytical Chemistry. India: Brooks/Cole, Cengage Learning.
7. Principles and Techniques of Biochemistry and Molecular Biology. (2010). United States: Cambridge University Press.
8. Basic principles in Physical and analytical Chemistry F. Y. B. Sc. Pure Chemistry Sem I Unit III.
9. Analytical Chemistry sixth edition by Caryd christian

SEMESTER-II

Paper-V Molecular Biology and Genetic Engineering (UBT2MBG)

Course Objective: To build a firm foundation of molecular biology and Genetic Engineering			
Learning Outcome: By the end of the course the student will: <ul style="list-style-type: none"> • Compare the replication in prokaryotes and eukaryotes • Classify the different types of mutations • Illustrate different DNA repair mechanisms. • Explain details of genetic engineering 			
Unit	Title	Credits	Lectures
UNIT I Replication	DNA Replication in Prokaryotes and Eukaryotes- Semi-conservative DNA replication, DNA Polymerases and its role, <i>E.coli</i> Chromosome Replication, Bidirectional Replication of Circular DNA molecules. Rolling Circle Replication, DNA Replication in Eukaryotes	2	15
UNIT II Mutation and DNA Repair	Mutations: 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
UNIT III Genetic Engineering	Genetic engineering: Definition and developments. What is gene cloning? Strategy for cloning How to clone a gene? How to construct rDNA? Source DNA [insert], Isolation of DNA from bacterial cell Enzymes in genetic engineering: Restriction endonuclease; DNA ligase; Enzymes to modify ends of DNA molecules - exonuclease; endonuclease; S1 nuclease; alkaline phosphatase; polynucleotide kinase; DNA polymerase and klenow fragment; reverse transcriptase; terminal deoxynucleotidyl transferase.		15

	<p>Vectors: Role as agents of transfer Features of plasmid vectors, Plasmid vectors - pBR322, pUC BAC Plant virus vectors and Animal virus vectors Shuttle vector; Expression vector.</p> <p>Host cells: E. coli; Bacillus subtilis; Saccharomyces cerevisiae; Xenopus oocytes; Mammalian fertilized egg cell.</p>		
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References

1. Russell, P. J., & Gordey, K. (2002). IGenetics, San Francisco: Benjamin Cummings.
2. Simmons, M. J., & Snustad, D. P. (2006). Principles of genetics. John Wiley & Sons.
3. Russell, P. J. (2000). Fundamentals of genetics. Longman Publishing Group. Nicholl, D. S. T. (2002).
4. An Introduction to Genetic Engineering (Studies in Biology). India: Cambridge University Press.
5. Brown, T. A. (2013). Gene Cloning and DNA Analysis: An Introduction. Germany: Wiley.
6. Genetic Engineering: Principles and Practice. (n.d.). India: McGraw-Hill Education.
7. A Textbook of Biotechnology by R C Dubey 4th Ed
8. Biotechnology: Fundamentals and Applications by S. S. Purohit

SEMESTER-II
Paper-VI Plant and Animal Physiology (UBT2PAP)

Course Objective: To provide an insight in to the different physiological processes of plants and animals.			
Learning Outcome: By the end of the course the student will: <ul style="list-style-type: none"> • Interpret the intracellular organization of photosynthesis and Pathway • Explain the Physiological Processes of Plants and functions of plant growth regulators. • Develop a comprehensive and deep understanding of the vital physiological processes of animals. • Understand concept of Human Nutrition 			
Unit	Title	Credits	Lectures
UNIT I Plant Physiology	<p>Photosynthesis:</p> <p>Hill's Reaction and its Significance, Light Reactions, Cyclic and Non-Cyclic Photo-induced Electron Flow, Energetics of Photosynthesis,</p> <p>Dark Phase of Photosynthesis, Calvin Cycle, C-3, C-4, CAM pathways, Rubisco oxygenase activity.</p> <p>Plant hormones: Structure and physiological roles- Auxin, Gibberellins, Cytokinins, Ethylene, Abscisic acid.</p>	2	15
UNIT II Animal Physiology	<p>Introduction to physiology:</p> <p>Concept of homeostasis.</p> <p>Blood: Functions of blood, general properties of blood, Composition of blood. Coagulation and Haemolysis of Blood.</p> <p>Respiratory system:</p> <p>Phases of Respiration, Principle of gaseous exchange, Mechanism of breathing.</p> <p>Digestion and absorption:</p> <p>Digestion and Absorption in humans.</p> <p>Excretion: Structure of kidney, Structure of nephron. Function of kidney, Urine formation, Dialysis</p>		
UNIT III Human Nutrition	<p>Definition of Nutrition,</p> <p>Basal metabolic rate: Factors affecting BMR, Measurements and its Significance, Human Energy requirement</p>		15

References

1. Cox, M. M., & Nelson, D. L. (2008). Lehninger principles of biochemistry (Vol. 5). New York: Wh Freeman.
2. Verma, S. K., Verma, M. (2008). A Textbook of Plant Physiology, Biochemistry and Biotechnology. India: S. Chand Limited.
3. Gujral, S. K., Kochhar, S. L. (2020). Plant Physiology: Theory and Applications. United States: Cambridge University Press.
4. Rastogi, S. C. (2007). Essentials of Animal Physiology. India: New Age International (P) Limited, Publishers.
5. Reddy, B. (2014). Text Book of Animal Pyhysiology. Andra Paresh, IMRF Publication.
6. Sembulingam, K. (2008). Essentials of Medical Physiology. India: Juta, Limited.
7. Sherwood, L. (2012). Introduction to Human Physiology. United States: Brooks/Cole.
8. Satyanarayana U. and Chakrapani U. (2007). Biochemistry. 3rd Edition. Books and Allied (P) Ltd.

SEMESTER-II
Paper-VII Laboratory Skills & Biostatistics (UBT2LSB)

Course Objective: To develop understanding of Laboratory Skills & Biostatistics			
Learning Outcome: By the end of the course the student will:			
<ul style="list-style-type: none"> • Make use of GLP,SOP and Biosafety guidelines • Develop skills towards preparation of standard solutions in the laboratory. • Understand the role of buffers • Organize the biological data using statistical tool 			
Unit	Title	Credits	Lectures
UNIT I Good Laboratory Practices and Biosafety Guidelines	<p>GLP: Concept of GLP, Objectives, Practicing GLP, Guidelines to GLP; Documentation of Laboratory work, Preparation of SOPs, Decontamination and Disposal</p> <p>Safety measures in Laboratory: Common safety symbols, General Work Procedure, Emergency Procedure, Apparel in the Laboratory, Chemical Handling.</p>	2	15
UNIT II Standard solutions and Buffers	<p>Preparation of standard Solutions: Concept and significance of Chemical and Biological solutions. Normality, Molarity, Molality, Mole fraction, Mole concept, Solubility, Weight ratio, Volume ratio, Weight to Volume ratio, ppb, ppm, millimoles, milliequivalents (Numerical expected).</p> <p>Primary and Secondary Standards: Preparation of Standard Solutions, Principle of Volumetric Analysis.</p> <p>Concept of pH: Buffer solutions –Concept of Buffers, Derivation of Henderson -Hasselback equation for Acidic and Basic buffers. Buffering capacity</p> <p>Biological buffers: Significance of biological buffers, Carbonate, Acetate and Phosphate buffers. Protein buffers (Introduction) Significance of TRIS buffers (Introduction)</p>		15
Unit III Biostatistics	<p>Introduction to Biostatistics: Definition & Importance of Statistics in Biology Variables, Types of variables (Quantitative & Qualitative)</p> <p>Types of Data and data visualization: Concept of Data, Sources of data, Types of data (Quantitative & Qualitative),</p> <p>Representation of Data and Graphs</p>		15

	<p>Sampling strategies: Population and Sample, Significance of using samples, , Sampling techniques</p> <p>Types of Statistics: Introduction to Descriptive & Inferential statistics</p> <p>Measures of central tendency: Mean, Mode, Median (Ungrouped & Grouped data)</p> <p>Measures of dispersion: Range, Variance, Standard deviation (Ungrouped & Grouped data), Coefficient of variation</p> <p>Measures of location: Percentiles, Interquartile range (Box-Whisker plot) Normal/Gaussian distribution, Standard normal deviate, Sampling variation, Standard error of mean</p>		
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References

1. World Health Organization, Laboratory biosafety manual – 3rd ed.2004.
2. A Guide to Biosafety and Biological Safety Cabinets ESCO.
3. Cox, M. M., & Nelson, D. L. (2008). Lehninger principles of biochemistry (Vol. 5). New York: Wh Freeman.
4. Satyanarayana U. and Chakrapani U. (2007). Biochemistry. 3rd Edition. Books and Allied (P) Ltd.
5. Mu, P., & Plummer, D. T. (2001). Introduction to practical biochemistry. Tata McGraw-Hill Education.
6. Khanal, A. B. (2015). Mahajan's Methods in Biostatistics For Medical Students and Research Workers. India: Jaypee Brothers,Medical Publishers Pvt. Limited.
7. Cross, C. L., Daniel, W. W. (2018). Biostatistics: A Foundation for Analysis in the Health Sciences. United Kingdom: Wiley.
8. Arora, P. N., Malhan, P. K. (2009). Biostatistics. India: Himalaya Publishing House.

SEMESTER-II
Paper-VII Communication Skills

Course Objective: To acquaint the students with different aspects of communication skills			
Learning Outcome: By the end of the course the student will: <ul style="list-style-type: none"> • Develop an understanding of communication skills required to excel in real work environment and corporate life. • Make use of technical and non-technical qualities in career planning • Learn about Leadership, team building, decision making and stress management 			
Unit	Title	Credits	Lectures
UNIT I Academic Skills	<p>Essentials of Grammar: Parts of speech, Articles, Modals, Sentences and their types., Punctuation marks</p> <p>Employment Communication: Introduction, Resume, Curriculum Vitae, Scannable Resume, Developing an Impressive Resume, Formats of Resume, Job Application or Cover Letter. Email Writing</p> <p>Professional Presentation: Nature of Oral Presentation, planning a Presentation, Preparing the Presentation, Delivering the Presentation</p> <p>Job Interviews: Introduction, Importance of Resume, Definition of Interview, Background Information, Types of Interviews, Preparatory Steps for Job Interviews, Interview Skill Tips, Changes in the Interview Process, FAQ During Interviews</p> <p>Group Discussion: Introduction, Ambience/Seating Arrangement for Group Discussion, Importance of Group Discussions, Difference between Group Discussion, Panel Discussion and Debate, Traits, Types of Group Discussions, topic based and Case based Group Discussion, Individual Traits</p>	2	15
UNIT II Soft and Professional Skills	<p>Introduction to Soft Skills and Hard Skills</p> <p>Personality Development: Knowing Yourself, Positive Thinking, Johari's Window, Communication Skills, Non-verbal Communication, Physical Fitness Definition</p>		15

	<p>Etiquette and Mannerism: Introduction, Professional Etiquette, Technology Etiquette</p> <p>Communication Techniques:</p> <p>Ethical Values: Ethics and Society, Theories of Ethics, Correlation, between Values and behavior, Nurturing Ethics, Importance of Work Ethics, Problems in the Absence of Work Ethics</p> <p>Leadership and Team Building: Leader and Leadership, Leadership Traits, Culture and Leadership, Leadership Styles and Trends, Team Building, Types of Teams</p>		
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References

1. Kumar, Sanjay, and Lata, Pushp. Communication Skills, Second Edition. India, Oxford University Press, 2015.
2. Chauhan, G. S., Sharma, S. (2016). Soft Skills: An Intergrated Approach to Maximise Personality. India: Wiley.
3. Mitra, B. K. (2011). Personality development and soft skills (Vol. 156). Oxford University Press. 16
4. Guffey, M. E., & Loewy, D. (2012). Essentials of business communication. Cengage Learning.
5. Rao, M. S. (2010). Soft skills-enhancing employability: connecting campus with corporate. IK International Pvt Ltd.
6. Sherfield, R. M. (2009). Cornerstone: Developing Soft Skills. Pearson Education India

PRACTICALS

Course Code	Title
UBT2PR1 (Practical of UBT2BIT2 & UBT2MAI)	<ol style="list-style-type: none"> 1. Preparation of Stock Solutions and Preparation of Media for PTC. 2. Aseptic Transfer Technique, Surface Sterilization (Seed sterilization) 3. Inoculation for Callus Culture. 4. Isolation and characterization of organisms causing Food Spoilage (Using Bergey's Manual) 5. Isolation and characterization of food fermenting organism from idli batter (Using Bergey's Manual) 6. Determination of food preservative concentration (salt & sugar) using MIC. 7. Detection of Food adulterants in food samples 8. Electron micrographs/diagrammatic study of: <ol style="list-style-type: none"> a. animal viruses (rhabdo, influenza, paramyxo, hepatitis and retroviruses) b. plant viruses (caulimo, gemini, tobacco ringspot, cucumber mosaic and alpha-alpha mosaic viruses) 9. Demonstration of Isolation and enumeration of bacteriophages (PFU) from water/sewage sample using double agar layer technique. 10. Motility by hanging drop method/stab culture 11. Methods of preservation of culture 12. Study of Growth Curve of <i>E. coli</i> 13. Preparation of vaccine (Demonstration) and Sterility testing of vaccine 14. Enumeration by Breed's count 15. Isolation and Enumeration of microorganisms- 16. Serial dilution, Surface spread method 17. Serial dilution, Pour plate method

	<p>18. Study of reaction pattern of an antigen with a set of antibodies by Ouchterlony double diffusion method</p> <p>19. Demonstration of Phagocytosis</p> <p>20. Study of bacterial flora of skin (as a physical barrier in innate immunity) by swab method/Hand imprint method.</p>
<p>UBT2PR2 (Practical of UBT2BCH2 & UBT2BOC2)</p>	<ol style="list-style-type: none"> 1. To determine enthalpy of dissolution of salt like KNO_3. 2. Determine the rate constant for hydrolysis of ester using HCl as a catalyst. 3. Study the kinetics of reaction between Thiosulphate ion and HCl. 4. Study reaction between potassium Persulphate and Potassium Iodide kinetically and hence to determine order of reaction. 5. Study the reaction between NaHSO_3 and KMnO_4 and balancing the reaction in acidic, alkaline and neutral medium. 6. Study transfer of electrons (Titration of sodium thiosulphate with potassium dichromate). 7. Determination of the volume strength of hydrogen peroxide solution by titration with standardized potassium permanganate solution. 8. Determination of amount of K oxalate and oxalic acid in the given solution titrimetrically. 9. Qualitative tests for lipids. 10. Iodine value of Oil. 11. Separation by Thin layer chromatography <ol style="list-style-type: none"> a. Plants Pigments b. Fatty acids. 12. Enzyme Kinetics: 13. Study of the effect of pH 14. Temperature on activity of Amylase 15. Study of Effect of substrate concentration on amylase enzyme activity and determination of V_{max} and K_m.

	<p>16. Study of Effect of enzyme concentration on amylase enzyme activity.</p> <p>17. Study of Effect of inhibitors on amylase enzyme activity.</p> <p>18. Determination of absorption maxima of CuSO₄/ K₂Cr₂O₇.</p> <p>19. Verification of Beer and Lambert's Law.</p> <p>20. Quantitative estimation of sugars by DNSA method</p> <p>21. Estimation of DNA by DPA method.</p>
<p>UBT2PR3 (Practical of UBT2MBG & UBT2PAP)</p>	<ol style="list-style-type: none"> 1. Study of Semiconservative replication of DNA through micrographs/ Schematic representation. 2. Agarose gel electrophoresis of genomic DNA 3. Study the effect of UV radiation as a mutagenic agent 4. Identification of types of point mutations from given DNA sequences 5. Isolation of antibiotic/ dye resistant mutants using replica plate technique. 6. Demonstration of Ames test for mutagenicity 7. Study of Hill's reaction 8. To measure the rate of photosynthesis by Winkler's method 9. Effect of PGRs on seed germination 10. Solvent extraction of plant pigments and study the absorption spectra of pigments 11. Qualitative detection of plant secondary metabolites using standard tests - e.g. Tests for tannins, flavonoids, alkaloids, terpenoids, saponins, steroids. 12. Separation of Carotenoids by thin layer chromatography 13. Separation of serum from blood 14. Effect of different concentrations of sodium chloride on RBC and determination of the concentration isotonic to blood. 15. Study of human blood count (RBC and WBC) using haemocytometer 16. Estimation of Hemoglobin in human blood. 17. Analysis of Urine