II विद्या विनयेन शोभतेII

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

Program: B.Sc. Degree Programme in Biotechnology

SYLLABUS

(Approved in the Academic council meeting held on 13/06/2024)

F.Y. B.Sc. Biotechnology

As per Revised National Education Policy
Choice Based Credit & Grading System (60:40)
w. e. f. Academic Year 2024-25

Preamble

Biotechnology is a multidisciplinary subject that deals with the application of biological components for human welfare. At Undergraduate level learners are offered various courses that would strengthen their fundamentals in Biotechnology and allied subjects such as Chemistry, Biochemistry, and Molecular Biology etc.

Learners after completing their biotechnology course can find suitable employment in the research and development, laboratories, pharmacies etc. The syllabus herein discusses the subjects offered at undergraduate level highlighting the respective course as well as program outcomes.

On completion of the course the learner will be skilled and equipped with contemporary knowledge in Biotechnology and would be eligible for jobs in varied industrial sectors. The students are offered skill enhancement course.

As per the guidelines under NEP Curriculum content is designed in each subject to its core essentials, to make space for critical thinking and more holistic, inquiry-based, discovery-based, discussion-based, and analysis-based learning.

DEPARTMENT OF BIOTECHNOLOGY

F.Y. B.Sc. Biotechnology

SEMESTER-I

Course Code	Course Type	Course Title	Credits
UBT1FBT	Course- 1	Fundamentals of Biotechnology	3+1
UBT1PR1	Practical Course-1	Practical of Fundamentals of Biotechnology	
UBT1CBI	Course-2	Cell Biology	3+1
UBT1PR2	Practical Course-2	Practical of Cell Biology	
UBT1BMI	Course-3	Basic Microbiology	3+1
UBT1PR3	Practical Course-3	Practical of Basic Microbiology	
USEC1IOB	Skill Enhancement Course	Instrumentation and Operating Skills in Biotechnology	02p
	Other courses	AEC+IKS+VEC+CC	08
			22

F.Y. B.Sc. Biotechnology

SEMESTER-II

Course Code	Course Type	Course Title	Credits
UBT2BCH	Course-4	Biological Chemistry	3+1
UBT2PR1	Practical Course-4	Practical of Biological Chemistry	
UBT2MBI	Course-5	Molecular Biology	3+1
UBT2PR2	Practical Course-5	Practical of Molecular Biology	
UBT2GEN	Course-6	Genetics	3+1
UBT2PR3	Practical Course-6	Practical of Genetics	
USEC2BMC	Skill Enhancement Course	Bio-business in Mushroom cultivation	02
UBT2PRM	Course- III	Practical- Genetics	
	Other courses	OE+AEC+VEC+CC	08
			22

Course-01: Fundamentals of Biotechnology	
Semester	**I**
Course Name	**Fundamentals of Biotechnology**
Course Code	**UBT1FBT**
Credit	**03 Theory+01Practical**

Course Objectives	• The course aims to introduce the fundamentals of biotechnology. The learner will be able develop complete understanding of the broad spectrum of biotechnology, emphasizing its relevance, applications in diverse sectors, and ethical considerations. • It explores the global demand, job prospects, and connections with other disciplines.
Course Outcomes	After completion of the course students will be able to:
CO-1	Define Biotechnology, exploring its historical context, and applications in various sectors along with the scope and significance of biotechnology globally and in India.
CO-2	Explain the applications of Biotechnology in various sectors like agriculture and environment.
CO-3	Outline the applications of Biotechnology in various sectors industry and medicine.

Units	Course Description	Hrs.
UNIT I Introduction to Biotechnology	• Definition, Traditional and Modern Biotechnology. • Branches of Biotechnology- Plant Biotechnology, Animal Biotechnology, Pharmaceutical Biotechnology, Industrial Biotechnology, Marine Biotechnology, and Environmental Biotechnology. • Biotechnology in India–Bio-business in India, booming biotech market, success story of biotech market, policy initiatives and global trends; potential of modern biotechnology, Ethics in Biotechnology. • Concept of Genetic Engineering and Recombinant DNA Technology.	15h

Unit II Applications of Biotechnology-I	• Environment Pollution: Role of Biotechnology in control of pollution • Agriculture: GM fruits- GM papaya, GM tomato, Insect resistant transgenic plants– Bt cotton, Bt brinjal, Modifications in nutrient quality –Golden rice, seed quality proteins. • Organic farming: Green manuring and organic fertilizers, recycling of biodegradable municipal, agricultural and Industrial wastes – biocompost making methods, types and method of vermicomposting. • Biofertilizers: Microbes used as biofertilizer – Rhizobium, Azospirillum, Cyanobacteria (blue green algae), Azolla and Anabaena, Mycorrhizal association.	15h
Unit III Applications of Biotechnology-II	• Animal Biotechnology: Transgenic animals- agriculture, medical and industrial applications. • Industry: Microbial enzyme applications • Forensic science: Solving violent crimes such as murder and physical assault, Significance of genetic marker typing data, solving claims of paternity and theft. • Health: recombinant vaccines, gene therapy, diagnostics, Edible vaccines. • Nutraceutical and functional foods: Role of nutraceuticals and functional foods in human health and disease management.	15h

References:

1. Dubey, R. C. (1993). A textbook of Biotechnology. S. Chand Publishing.
2. Dubey, R. C. (2014). Advanced biotechnology. S. Chand Publishing.
3. Singh, B. D., & Singh, B. D. (2007). Biotechnology expanding horizons. Kalyani publishers.
4. Klaus Buchholz and John Collins. Concepts in Biotechnology-History, Science and Business-Wiley-VCH
5. Genetic Engineering: Principles and Practice. (n.d.). India: McGraw-Hill Education.
6. Principles of Gene Manipulation and Genomics - Richard M Twyman and S. B. Primrose.

Practical Course- 1

Practical of Fundamentals of Biotechnology

Course Objectives	This course aims to give hands-on training in to gain laboratory skills and expertise in recent biotechnological advancements through experiments, case studies, demonstrations, and virtual visits, thus linking theory with practical insights.
Course Outcomes	After completion of the course students will be able to:
CO1	Analyze and report on recent biotech applications to demonstrate understanding and application of theoretical knowledge.
CO2	Conduct virtual visits to research institutes, fostering skills in navigating and extracting valuable information from scientific resources.
CO3	Gain hands-on experience on isolation and estimation techniques o DNA

UBT1PR1 (30 Hrs.)	
1.	Isolation of DNA from Onion.
2.	Estimation of DNA by DPA method.
3.	Agarose gel electrophoresis of isolated DNA.
4.	A case study of GMOs.
5.	A case-study on any one recent application of Biotechnology.
6.	Preparation of compost.
7.	Tenderization of meat using enzymes.
8.	Field visit to National/ International research institutes for research in biotechnology.

Course-02: Cell Biology	
Semester	**I**
Course Name	**Cell Biology**
Course Code	**UBT1CBI**
Credit	**03 Theory+01Practical**

Course Objectives	The course aims to introduce the fundamentals of concepts of cell biology like cell structure, functions, cell cycle and its regulation.
Course Outcomes	After completion of the course students will be able to:
CO-1	Explain ultrastructure of prokaryotic and eukaryotic cells.
CO-2	Illustrate membrane structure and functions.
CO-3	Outline the cell cycle phases with its regulation.

Units	Course Description	Hrs.
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, 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, Eukaryotic Ribosomes, Mitochondria, and Chloroplasts. • Nucleus–Nuclear Structure, Nucleolus, Cilia and Flagella. • Comparison of Prokaryotic and Eukaryotic Cells.	15h

UNIT II Membrane Structure and Function	• 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 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.	15h
UNIT III Cell cycle and Regulation	• Cell Cycle and regulation in Prokaryotic and Eukaryotic cell- • Phases of cell cycle (G0, G1, G2, M phases), checkpoints in cell cycle regulation. • Mitosis and Meiosis and their significance; Control of mitosis by cyclins, MPF activity and cyclin-dependent kinases, • Programmed Cell Death-Introduction to Apoptosis, Apoptosis pathways and its regulation; Difference in Apoptosis and necrosis.	

References:

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.

Practical Course- 2

Practical of Cell Biology

Course Objectives	Understand fundamental cellular processes through hands-on exploration of mitosis and meiosis.
Course Outcomes	After completion of the course students will be able to:
CO-1	explain and demonstrate the steps of mitosis and meiosis
CO-2	demonstrate basic techniques of cell biology

	UBT1PR2 (30 Hrs.)
1.	Monochrome staining using plant /animal tissue.
2.	Special Staining Technique for Cell Wall
3.	Special Staining Technique for capsule.
4.	Isolation of cell organelles by density gradient centrifugation.
5.	Effect of different concentrations of sodium chloride on RBC and determination of the concentration isotonic to blood.
6.	Study of mitosis from suitable plant material
7.	Study of meiosis from suitable plant material/Permanent slides/Photographs
8.	Study of mitosis using pre-treated root tips of *Allium cepa* to study the effect of mutagens- chemical(colchicine/ PDB) on mitosis

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Course-3 Basic Microbiology	
Semester	**I**
Course Name	**Basic Microbiology**
Course Code	**UBT1BMI**
Credit	**03 Theory+01Practical**

Course Objectives	• Develop a comprehensive understanding of microbial science by exploring the history, classification, and cultivation techniques, emphasizing the role of microorganisms in everyday life. • Acquire proficiency in microscopy principles, and applications.
Course Outcomes	After completion of the course students will be able to:
CO-1	State the microbial world's historical context, classification, and cultivation techniques.
CO-2	Make use of sterilization and disinfection techniques.
CO-3	Apply microscopy principles effectively, showcasing proficiency in optics, staining techniques, and practical applications.

Units	Course Description	Hrs.
UNIT I Introduction to Microbiology	• Discovery of Microorganisms, Conflict over spontaneous generation. • 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.	15h

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. • Disinfectant: Ideal Disinfectant. Examples of Disinfectants and Evaluation of Disinfectant	15h
UNIT III Microscopy and stains	• 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. • Principle, working and applications of Bright Field Microscope, Dark Field Microscope; Phase Contrast Microscope, Fluorescent Microscope. • Stains and Staining Solutions- Definition of Dye and Chromogen; acidic and basic dyes; functions of chromophore and auxochrome groups. Definition and function of stain; mordant, intensifiers and Fixative. Simple, negative, differential staining and special staining.	15h

References:

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)
8. J Sambrook & EF Fritsch, Molecular Cloning: A laboratory manual, Cold Spring Harbor Laboratory press, U.S.A.
9. S.B Primrose, R M Twyman, Principles of Gene Manipulation and Genomics, Blackwell Science (Asia Pvt Ltd).

Practical Course- 3

Practical of Basics of Microbiology

Course Objectives	To demonstrate methods for isolating and quantifying microorganisms from various sources, emphasizing on aseptic techniques and proper handling.
Course Outcomes	After completion of the course students will be able to:
CO-1	Hands-on experience in isolation techniques, microbial enumeration.
CO-2	Isolate and quantify microorganisms from various sources using aseptic techniques.
CO-3	Maintain accurate laboratory records, including observations, procedures, and results.

	UBT1PR3 (30 Hrs.)
1.	Microscopy– Description and operation of compound Microscope, use of oil immersion objective. (Including Handling and storage)
2.	Preparation of Media- Nutrient broth and Agar, MacConkey Agar, Sabourauds, Agar.
3.	Aseptic transfer technique (tube to tube, tube to plate, pipette to tube).
4.	Isolation of Organisms: T-streak, Polygon method.
5.	Enumeration of microorganisms by Serial Dilution, Pour Plate, Spread PlateMethod.
6.	Monochrome staining using any suitable material.
7.	Negative staining
8.	Differential staining –Gram staining

DEPARTMENT OF BIOTECHNOLOGY

Skill Enhancement Course - Instrumentation and Operating Skills in Biotechnology	
Semester	**I**
Course Name	**Instrumentation and Operating Skills in Biotechnology**
Course Code	**USEC1IOB**
Credit	**02**

Course Objectives	The course is an elementary course in instrumentation and Operating Skills used in Biotechnology that forms the foundation of analytical techniques. The knowledge and handling of instruments is necessary in academics, research work and industry.
Course Outcomes	After completion of the course students will be able to:
CO-1	Apply the use and operations of basic laboratory instruments in Biotechnology
CO-2	Explain principle, instrumentation and applications of basic techniques used in biotechnology.

1.	Study of laboratory symbols, Safety Measures and Good laboratory Practices (GLP) in Chemistry Laboratory.
2.	Preparation of Solutions: Normal, Molar and percentage solution (%W/W, %V/V, %W/V), ppb and ppm.
3.	Validation of glass pipettes and Measuring cylinders.
4.	Buffer solutions – Concept of Buffers, Types of Buffers, Derivation of Henderson equation for Acidic and Basic buffers, Buffer action, Buffer capacity.
5.	Preparation of pH Buffer standards and Calibration of pH meter.
6.	a. To study Beer Lambert's law and Determination of lambda max of colored solutions.
	b. Verification of Beer Lambert's law.
7.	Validation and handling of Autoclave.
8.	Separation of amino acids by Paper chromatography.
9.	Separation of plant pigments by TLC.
10.	Principle, Working and applications of Centrifuges and its types.
11.	Data Handling in Biological sciences. Plotting Graphs, Types of graphs and data interpretation.
12.	Determination of Acetic acid in Vinegar by Titrimetric Method.
13.	Determination of percent composition of $BaSO_4$ and NH_4Cl in the given mixture gravimetrically.

References:

1. Biochemical Methods by Sadasivam, S, Manickam, A. Publisher: New Age International
2. An introduction to practical biochemistry By Plummer, David T
3. Lab Ref, Volume 1 A Handbook of Recipes, Reagents, and Other Reference Tools for Use at the Bench, Edited by Jane Roskams, University of British Columbia, Canada; Linda Rodgers, Cold Spring Harbor Laboratory
4. Lab Math: A Handbook of Measurements, Calculations, and Other Quantitative Skills for Use at the Bench, Second edition 2nd Edition, Cold Spring Harbor Laboratory Press

SEMESTER-II

Course-4 Biological Chemistry	
Semester	**II**
Course Name	**Biological Chemistry**
Course Code	**UBT2BCH**
Credit	**03 Theory+01Practical**

Course Objectives	This course aims to introduce the fundamentals of Biochemistry. The students will learn about the biomolecules with their physiological significance.
Course Outcomes	After completion of the course students will be able to:
CO-1	Classify different types of bonds and organic Reaction mechanisms.
CO-2	Explain the biomolecules like carbohydrates and lipids with their physiological significance.
CO-3	Discuss the amino acids and proteins with their structure and functions.

Units	Course Description	Hrs.
UNIT I Chemical bonds and Chemistry of Water	• Chemical Bonds: Bonds stabilizing biomolecules-ionic Bond, Covalent bonds, hydrogen bonding, hydrophobic interaction, disulphide bonds. Dipole-dipole interactions, London forces. • Chemistry of Water: Structure and Properties of Water. • Organic Reaction Mechanisms A. Chemical Logic B. Group-Transfer Reactions C. Oxidations and Reductions D. Eliminations, Isomerizations, and Rearrangements E. Reactions That Make and Break Carbon–Carbon Bonds. • Bioenergetics- Laws of thermodynamics, concept of free energy, enthalpy and entropy. Thermodynamics of Phosphate Compounds A. Phosphoryl-Transfer Reactions B. Rationalizing the “Energy” in “High-Energy” Compounds C. The Role of ATP.	15h

UNIT II : Carbohydrates and Lipids	Carbohydrates: • Classification and functions of Carbohydrates • Structure, Function, properties and reactions of Monosaccharaides. • Structures and functions of biologically important Disaccharides. • Polysaccharides-Homo and Hetero Polysaccharides, Mucopolysaccharides, Bacterial cell wall poly-saccharides Lipids: • Classification, functions of Lipids, nomenclature and properties of fatty acids, essential fatty acids. • Lipids of Biological Significance-Phospholipids, sphingolipids, glycol-lipids, cerebrosides, gangliosides, Prostaglandins and Cholesterol.	15h
Unit III: Amino Acids and Proteins	Amino acids and Protein: • Classification, Structure and properties of Amino acids, Isoelectric Point, Peptide Synthesis. Reactions of Amino Acids, Sorenson's Titration, Ninhydrin Test. • Titration Curve of Amino Acids. Concept of Isoelectric pH, Zwitter ion. • Types of proteins, their classification based on Structure and Functions. • Primary Structure, Secondary, tertiary and quaternary structure of proteins with suitable examples. • Denaturation and renaturation of proteins.	15h

Reference Books:

1. Outline of Biochemistry, Fifth edition, Eric e.Conn, Paul K. Stumpf, George Bruening, Roy H. Doi,Wiley-INDIA,John Wiley and Sons Inc. (P), Ltd .
2. Concise Inorganic Chemistry. 5th edition (2008), Author: J. D. Lee, John Wiley & Sons, USA.
3. Skoog, D. A., West, D. M., Holler, F. J., & Crouch, S. R. (2013). Fundamentals of analytical chemistry.
4. Guide book to Mechanism in Organic Chemistry by Peter Sykes, 6 th edition, (1996), Prentice Hall, India.
5. Vogel, A. I., & Jeffery, G. H. (1989). Vogel's textbook of quantitative chemical analysis. Wiley.

PRACTICAL OF COURSE-4 Biological Chemistry	
Course Objectives	To adopt the practical skills in biochemistry and biochemical tehniques.
Course Outcomes	After completion of the course students will be able to:
CO-1	Analyses the different biomolecules qualitatively and quantitatively.
CO-2	Develop the practical skills in biochemistry.

	UBT2PR1 (30 Hrs.)
1.	Qualitative Analysis of carbohydrates.
2.	Qualitative Analysis of amino acids, Proteins and lipids.
3.	Estimation of reducing sugars by DNSA method.
4.	Protein estimation by Biuret method.
5.	Separation of lipids by TLC.
6.	Estimation of Amino acids by Formal Titration.
7.	Isolation of Casein from Milk and Study of isoelectric pH.

Course-5 Molecular Biology	
Semester	**II**
Course Name	**Molecular Biology**
Course Code	**UBT2MBI**
Credit	**03 Theory+01Practical**

Course Objectives	This course aims to develop insights in the field of molecular biology
Course Outcomes	After completion of the course students will be able to:
CO-1	Explain structure and functions of nucleic acids.
CO-2	Compare the replication in prokaryotes and eukaryotes.
CO-3	Illustrate different types of mutations and DNA repair mechanisms.

Units	Course Description	Hrs.
UNIT I Structure of Nucleic acids	• Structure of nucleoside, nucleotides and Polynucleotides, • Structure of DNA, DNA double helix, Watson and Crick's model. • Clover leaf model of RNA, Types of RNA Structure • Chargaff's rule • DNA denaturation, Cot Curve	
UNIT II DNA Replication	DNA Replication in Prokaryotes- • Evidence of Semi-conservative DNA replication- Messelhson and stahl's experiment. • DNA Polymerases and its role • E. coli Chromosome Replication, semi discontinuous replication, pulse chase experiment by R Okazaki • Bidirectional Replication of Circular DNA molecules, • Rolling Circle Replication, theta model of replication DNA Replication in Eukaryotes- • detail steps and role of telomerases • Enzymes and proteins involved in DNA replication	15h

Unit III Mutation and DNA Repair	• Mutation- Definition and Types of Mutations. Mutagenesis and Mutagens. (Examples of Physical, Chemical and Biological Mutagens) • DNA Repair: Photoreversal, Base excision Repair, Nucleotide Excision Repair, Mismatch Repair, SOS Repair and Recombination Repair.	15h

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.

Practical of Course-V Molecular Biology

Course Objectives	To build hands-on experience in molecular biology techniques
Course Outcomes	After completion of the course students will be able to:
CO-1	Demonstrate basic techniques of molecular biology.
CO-2	Develop practical skills in DNA extraction, qualitative/quantitative analysis.

	UBT2PR2 (30 Hrs.)
1.	Estimation of DNA by UV-spectrophometric method.
2.	Estimation of RNA by Orcinol method.
3.	To study the effect of physical mutagen on bacteria.
4.	To study the effect of chemical mutagen on bacteria.
5.	Extraction and isolation of Genomic DNA from *E. coli*.
6.	Separation and visualization of DNA by Agarose gel electrophoresis (Demo)
7.	Assignment on to make model on DNA helix /Replication/DNA damage.

Course-6 Genetics	
Semester	**II**
Course Name	**Genetics**
Course Code	**UBT2GEN**
Credit	**03 Theory+01Practical**

Course Objectives	To acquaint students with basic concepts of genetics, cytogenetics and gene transfer mechanism in bacteria
Course Outcomes	After completion of the course students will be able to:
CO-1	Illustrate principles of Mendelian genetics and gene interaction
CO-2	Explain structure, organization of chromosome and mechanism of sex determination
CO-3	Discuss mechanism of genetic exchange in bacteria.

Units	Course Description	Hrs.
UNIT I Fundamentals of Genetics	• Introduction to genetic and sub-disciplines of genetics: Transmission genetics, Molecular genetics, Population genetics and Quantitative genetics. • Basic Terminologies in genetics Mendelian Genetics: Monohybrid Crosses and Mendel's Principle of Segregation Dihybrid crosses and Mendel's Principle of Independent Assortment. • Extensions of and Deviations from Mendelian Genetic Principles: Multiple Alleles - ABO Blood groups Modifications of Dominance Relationships: Incomplete Dominance and Co-dominance. Environmental effect on the expression of the Human Genes. • Gene Interactions and Modified Mendelian Ratios- Epistatic and non-epistatic interactions Essential Genes and Lethal Alleles	15h

UNIT II Cytogenetics	• Structure and organization of eukaryotic • Genetic material – Histone and nonhistone Proteins, nucleosome structure. • Heterochromatin, Euchromatin, Polytene Chromosomes, Lampbrush chromosome. • Chromosomal banding techniques Karyotype and Idiogram Variation in Chromosomal Structure and Number: Deletion, Duplication, Inversion, Translocation, Aneuploidy, Euploidy and Polyploidy and Syndromes- Klinefelter, Turner, Cri-du-Chat, Trisomy-21, Trisomy-18and Trisomy-13. • Sex Determination and Sex Linkage: Mechanisms of Sex Determination (XX-XY, ZZ- ZW, XX-XO) • Dosage Compensation and Barr body.	
UNIT III 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.	

References

1. Russell, P. J., & Gordey, K. (2002). IGenetics, San Francisco: Benjamin Cummings.
2. Verma, P. S., & Agarwal, V. K. (2004). Cell Biology, Genetics, Molecular Biology, 13 Evolution and Ecology: Evoloution 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.

Course-6 Practical

Genetics

Course Objectives	The course is designed to give a base and technical knowledge of genetics.
Course Outcomes	After completion of the course students will be able to:
CO-1	Solve problems based on genetic concepts and their practical applications
CO-2	Hands on experience on basic techniques in genetics.

	UBT2PR3 (30 Hrs.)
1.	Problems based on Mendelian Genetics, its modifications and gene interactions.
2.	Study of polytene chromosome
3.	Study of Normal Karyotype
4.	Study of Abnormal Karyotypes: Klinefelter, Turner, Cri-du-Chat, Trisomy-21, Trisomy-18and Trisomy-13.
5.	Barr body identification in cells of Buccal smear
6.	Preparation of competent cells and demonstration of Bacterial transformation and mapping
7.	Demonstration of Bacterial Conjugation and interrupted mating-based mapping
8.	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.)
9.	Study of blood groups ABO in humans

Skill Enhancement Course - Bio-business in Mushroom cultivation	
Semester	**II**
Course Name	**Bio-business in Mushroom Cultivation**
Course Code	**USEC1BMC**
Credit	**02**

Course Objectives	Course is designed to develop entrepreneur skills of mushroom cultivation.
Course Outcomes	After completion of the course students will be able to:
CO-1	Apply the methods of making value added mushroom products.
CO-2	Analyse nutritive values of mushroom products and its cost.
CO-3	Design a business plan of Mushroom Cultivation.

1.	To study different parts of a typical mushroom & variations in Mushroom morphology and different types of Mushrooms.
2.	Sterilization of glassware, equipment, and culture media used in mushroom cultivation
3.	Preparation of culture media: Potato Dextrose medium and Richards's medium.
4.	Preparation of spawn
5.	Preparation of compost and known compost formulations
6.	Mushroom bed preparation
7.	Preparation of Mother spawn
8.	Cultivation of Oyster mushroom
9.	Nutrient profiling and Medicinal value of mushrooms.
10.	Preparation of compost and known compost formulations
11.	Preservation of mushrooms - freezing, dry freezing, drying, canning
12.	Preparation of different recipes in mushroom cuisine
13.	Packaging and labeling and cost benefit analysis in mushroom cultivation.
14.	Designing the Business plan in Mushroom cultivation
15.	Records and documentations by the commercial unit for audit

References:

1. Anupam Mishra, SRK Singh and MP Thakur: Training Manual on Cultivation of Tropical Mushroom and its Value addition. Agricultural Technology ApplicationResearch Institute - ICAR - Zone VII, JNKVV, Jabalpur
2. Nailoke Pauline Kadhila, Favian SInvula Mubiana, and Keumbo Lorna Halueendo, 2012: Mushroom Cultivation - A Beginners Guide; Published by University of Namibia
3. Nita Bhal. (2000). Handbook on Mushrooms. 2nd ed. Vol. I and II. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
4. Pandey R.K, S. K Ghosh, 1996. A Handbook on Mushroom Cultivation. Emkey Publications.
5. Pathak, V. N. and Yadav, N. (1998). Mushroom Production and Processing Technology. Agrobios, Jodhpur.
6. Tewari Pankaj Kapoor, S. C. (1988). Mushroom Cultivation. Mittal Publication, New Delhi.
7. Tripathi, D.P. (2005) Mushroom Cultivation, Oxford & IBH Publishing Co. PVT.LTD, New Delhi.
8. V.N. Pathak, Nagendra Yadav and Maneesha Gaur, Mushroom Production and Processing Technology/ Vedams Ebooks Pvt Ltd., New Delhi (2000).
9. National Institute of Open Schooling: https://nios.ac.in/media/documents/vocational/mushroom_production_(revised)(618)/Practical_Manual.pdf

Scheme of Examination (Amended)
Faculty of Science
(Under-graduate Programmes)

Choice Based Credit System (CBCS)

❖ **Revised Scheme of Examination**

1. For 4 or 3 Credits Courses (Discipline Specific Courses (DSC)/Major/Minor Courses) (100 Marks)

The performance of the learners shall be evaluated into two components, as the first component by 'Continuous Internal Assessment (CIA)' with 40% marks and as the second component by conducting the 'Semester End Examinations (SEE)' with 60% marks. The allocation of marks for the Continuous Internal Assessment (CIA) and Semester End Examinations are as shown below:

A) Continuous Internal Assessment (CIA): 40 % 40 Marks

Sr. No.	Particular	Marks
01	One periodical class test / online examination to be conducted in the given semester	20 Marks
02	Test on Practical Skills/ Case studies /Group/ Individual Survey Project/Presentation and write up on the selected topics of the subjects/ Book Review / Open Book Test	15 Marks
03	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibition of leadership qualities in organizing related academic activities	05 Marks

Question Paper Pattern (Periodical Class Test)

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/True or False/ 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 (SEE): 60 % 60 Marks

- Duration: The examination shall be of 2 hours duration.

Question Paper Pattern

Theory question paper pattern
1. There shall be three/four questions each of 20/15 marks. 2. All questions shall be compulsory with internal options. 3. Question may be subdivided into sub-questions a, b, c… and the allocation of marks depends on the weightage of the unit.

- **Practical Examination (PE) for Discipline Specific Courses (DSC) / Minor Courses 50 Marks**
  The Practical Examination (PE) shall be of 50 marks for Discipline Specific Courses (DSC)/Minor Courses.
- **Practical Examination (PE) for Major Courses (Semester III & Semester IV) 100 Marks**
  The Practical Examination (PE) shall be of 100 marks for Major Courses of Semester III & Semester IV.

2. For 2 Credits Courses (VEC/AEC/IKS/CC Courses) (50 Marks)

The performance of the learners shall be evaluated into two components, as the first component by 'Continuous Internal Assessment (CIA)' with 40% marks and as the second component by conducting the 'Semester End Examinations (SEE)' with 60% marks. The allocation of marks for the Continuous Internal Assessment (CIA) and Semester End Examinations (SEE) are as shown below:

A) Continuous Internal Assessment (CIA): 40 % 20 Marks

Sr. No.	Particular	Marks
01	One periodical class test / online examination to be conducted in the given semester	20 Marks

Question Paper Pattern (Periodical Class Test)

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 (SEE): 60 % 30 Marks

- Duration: The examination shall be of 1 hour's duration.

Question Paper Pattern

Theory question paper pattern
1. There shall be two/three questions each of 15/10 marks. 2. All questions shall be compulsory with internal options. 3. Question may be subdivided into sub-questions a, b, c… and the allocation of marks depends on the weightage of the unit.

3. For 2 Credits Courses (Skill Enhancement Courses (SEC)) Practical Examination (PE) (50 Marks)

The Practical Examination (PE) shall be of 50 marks for Skill Enhancement Courses (SEC)

Journal/ Viva Voce	10 Marks
Practical Examination (PE)	40 Marks

4. For 2 Credits Courses (Open Elective (OE) Courses) (50 Marks)

The performance of the learners shall be evaluated into two components. The allocation of marks are as shown below:

A) Case Studies/Projects/Field Work (FW)/Test Based on Tutorials/Open Book Test: 40 % 20 Marks

Workbook/Lab book/ Viva Voce/Write up	05 Marks
Case Studies/Projects/ Field work /Laboratory Work /Test based on tutorials/Open Book Test	15 Marks

B) Semester End Examination (SEE): 60 % 30 Marks

- Duration: The examination shall be of 1 hour duration.

Question Paper Pattern

Theory question paper pattern
1. There shall be two/three questions each of 15/10 marks. 2. All questions shall be compulsory with internal options. 3. Question may be subdivided into sub-questions a, b, c… and the allocation of marks depends on the weightage of the unit.

5. For 2 Credits Field Project (FP)/Community Engagement Project (CEP) / Research Project (RP) (50 Marks)

- The performance of the learners shall be evaluated 50 Marks.

Passing Standard

- **1. For 4 or 3 Credits Courses (Discipline Specific Courses (DSC)/Major/Minor Courses):** The learners shall obtain minimum of 40% marks (i.e. 16 out of 40) in the Continuous Internal Assessment (CIA) and 40% marks in Semester End Examination (SEE) (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 Continuous Internal Assessment (CIA) and Semester End Examination (SEE).
- **For 2 Credits Courses AEC, VEC, VSC, SEC, IKS, OE, FP, CEP, RP and CC courses:** Learners should remain present for Continuous Internal Assessment (CIA) and Semester End Examination (SEE)/ Practical Examination (PE). A learner will be said to have passed the course if the learner obtains minimum of 40% marks in the Continuous Internal Assessment (CIA) and Semester End Examination (SEE)/ Practical Examination together and obtain minimum 10 marks out of 30 marks in Semester End Examination (SEE)/ Practical Examination (PE).
- **For Practical Examinations (PE):** The learners shall obtain minimum of 40% marks (i.e. 20 out of 50) in Practical Examination (PE), to pass the course and minimum of Grade D, wherever applicable, to pass a particular semester.

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

- **Rules of A.T.K.T. for Revised NEP 2020 structure of Academic Year 2024-25**

1. A learner shall be allowed to keep term for Semester II irrespective of the number of courses of failure in the Semester I.
2. A learner shall be allowed to take admission to Semester III if he/she passes both Semester I and Semester II.

   OR

   A learner shall be allowed to keep term for Semester III, if he/she fails in not more than four Discipline Specific Courses (DSC) and not more than six other courses of Semester I and Semester II taken together with not more than two Discipline Specific Courses (DSC) and not more than three other courses each in Semester I and Semester II.
3. A learner shall be allowed to keep term for Semester IV irrespective of the number of courses of failure in the Semester III.

4. A learner shall be allowed to take Admission to Semester-V and Keep Terms if he/she Passes in both Semester-I and Semester-II and failed in not more than four Discipline Specific Courses (DSC) and not more than six other courses of Semester – III and Semester – IV taken together with not more than two Discipline Specific Courses (DSC) and not more than three other courses each in Semester – III and Semester – IV

   OR

   Passes in both Semester-III and Semester-IV and failed in not more than four Discipline Specific Courses (DSC) and not more than six other courses of Semester – I and Semester – II taken together with not more than two Discipline Specific Courses (DSC) and not more than three other courses each in Semester – I and Semester – II.
5. A learner shall be allowed to keep term for Semester VI irrespective of the number of courses of failure in the Semester V.
6. The result of Semester-VI shall be withheld by the College till the learner passes all the Semesters from I – V.
7. A Learner is allowed to take admission in semester VII (UG Hon. /PG Part I) only if he passed all courses of semesters I to VI (132 Credits).

- **Eligibility Condition to appear for Additional Examination of any Semester (Applicable only for Regular Semester End Examinations)**

A learner who remains absent in some or all the subjects on medical grounds or for representing the College or University in NSS, NCC, Sports, Cultural Activities or co-curricular/extracurricular/extension activities with prior permission of the Principal or Head of the institute reported to the examination section, by producing necessary documents and testimonials, will be allowed to appear for the Additional Semester End Examination (ASEE). This is not applicable for any A.T.K.T. / Supplementary Examinations.

- **Supplementary Examination (SE)**

The college will conduct supplementary examinations for semester II, IV, and VI after the declaration of their respective results.

Note:

1) It is noted that the concerned regulation of the College is amended and implemented to Semester I to Semester IV of undergraduate programmes, under faculty of Arts, Commerce and Science with effect from the academic year 2024 - 2025. All these rules may be amended as and when required with authorisation of Academic bodies.

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II विद्या विनयेन शोभते II

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

Program: B.Sc. Degree Programme in Biotechnology

SYLLABUS

(Approved in the Academic council meeting held on 13/06/2024

S.Y. B.Sc. Biotechnology

As per National Education Policy
Choice Based Credit & Grading System (60:40)
w. e. f. Academic Year 2024-25

Department of Biotechnology

B.Sc. Biotechnology

Course Code	Course Type	Course Title	Credits
UBT3BIC	Major Course-5	Biochemistry	**4 (3+1)**
UBT3MBG	Major Course-6	Membrane Biology and Genetics	**4 (3+1)**
UBT3PR1	Practical Major Course-5 and 6	Practical- Biochemistry (UBT 3BIC) and Membrane Biology and Genetics UBT3MBG	
UBT3MEM	Minor Course-2	Medical Microbiology	**4 (2+2)**
UBT3PR2	Minor Course Practical	Practical-Medical Microbiology UBT3MEM	
UVSC3FBT	Vocational Skill Course-3	Food Biotechnology	**02**
UOE3IBD	Open Elective-3	Introduction to Biotechnology for domestic Waste Management	**02**
		OE+CC+VAC+AEC+ ((Other Departments)	**08**
			22

Semester-IV

S.Y. B.Sc. Biotechnology

Course code	Course Type	Course Title	Credits
UBT4MET	Major Course-7	Metabolism	**4 (3+1)**
UBT4 MOB	Major Course-8	Molecular Biology- II	**4 (3+1)**
UBT4 PR1	Practical Major Course-7 and 8	Practical - Metabolism (UBT4MET) and Molecular Biology- II (UBT4 MOB)	
UBT4BPT	Minor Course-3	Bioprocess Technology	**4 (2+2)**
UBT4 PR2	Minor Course-3 Practical	Practical -Bioprocess Technology (UBT4BPT)	
USEC4BTE	Skill Enhancement Course-3	Practical- Bioanalytical Techniques	**02**
UOE4 SFA	Open Elective-4	Soilless Farming	**02**
		CC+VAC+AEC (offered by the other Departments)	**06**
			22

Department of Biotechnology

Scheme of Examination (Amended)
Faculty of Science
(Under-graduate Programmes)

Choice Based Credit System (CBCS)

❖ **Revised Scheme of Examination**

1. For 4 or 3 Credits Courses (Discipline Specific Courses DSC/Major/Minor Courses) (100 Marks)

The performance of the learners shall be evaluated into two components, as the first component by 'Continuous Internal Assessment (CIA)' with 40% marks and as the second component by conducting the 'Semester End Examinations (SEE)' with 60% marks. The allocation of marks for the Continuous Internal Assessment (CIA) and Semester End Examinations are as shown below:

A) Continuous Internal Assessment (CIA): 40 % 40 Marks

Sr. No.	Particular	Marks
01	One periodical class test / online examination to be conducted in the given semester	20 Marks
02	Test on Practical Skills/ Case studies /Group/ Individual Survey Project/Presentation and write up on the selected topics of the subjects/ Book Review / Open Book Test	15 Marks
03	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibition of leadership qualities in organizing related academic activities	05 Marks

Question Paper Pattern
(Periodical Class Test)

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/True or False/ 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 (SEE): 60 % 60 Marks

- Duration: The examination shall be of 2 hours duration.

Question Paper Pattern

Theory question paper pattern
1. There shall be three/four questions each of 20/15 marks. 2. All questions shall be compulsory with internal options. 3. Question may be subdivided into sub-questions a, b, c… and the allocation of marks depends on the weightage of the unit.

- **Practical Examination (PE) for Discipline Specific Courses (DSC) / Minor Courses 50 Marks**

  The Practical Examination (PE) shall be of 50 marks for Discipline Specific Courses (DSC)/Minor Courses.

- **Practical Examination (PE) for Major Courses (Semester III & Semester IV) 100 Marks**

  The Practical Examination (PE) shall be of 100 marks for Major Courses of Semester III & Semester IV.

2. For 2 Credits Courses (VEC/AEC/IKS/CC Courses) (50 Marks)

The performance of the learners shall be evaluated into two components, as the first component by 'Continuous Internal Assessment (CIA)' with 40% marks and as the second component by conducting the 'Semester End Examinations (SEE)' with 60% marks. The allocation of marks for the Continuous Internal Assessment (CIA) and Semester End Examinations (SEE) are as shown below:

A) Continuous Internal Assessment (CIA): 40 % 20 Marks

Sr. No.	Particular	Marks
01	One periodical class test / online examination to be conducted in the given semester	20 Marks

Question Paper Pattern
(Periodical Class Test)

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 (SEE): 60 % 30 Marks

- Duration: The examination shall be of 1 hour's duration.

Question Paper Pattern

Theory question paper pattern
1. There shall be two/three questions each of 15/10 marks. 2. All questions shall be compulsory with internal options. 3. Question may be subdivided into sub-questions a, b, c… and the allocation of marks depends on the weightage of the unit.

3. For 2 Credits Courses (Skill Enhancement Courses (SEC)) Practical Examination (PE) (50 Marks)

The Practical Examination (PE) shall be of 50 marks for Skill Enhancement Courses (SEC)

Journal/ Viva Voce	10 Marks
Practical Examination (PE)	40 Marks

4. For 2 Credits Courses (Open Elective (OE) Courses) (50 Marks)

The performance of the learners shall be evaluated into two components. The allocation of marks are as shown below:

A) Case Studies/Projects/Field Work (FW)/Test Based on Tutorials/Open Book Test: 40 % 20 Marks

Workbook/Lab book/ Viva Voce/Write up	05 Marks
Case Studies/Projects/ Field work /Laboratory Work /Test based on tutorials/Open Book Test	15 Marks

B) Semester End Examination (SEE): 60 % 30 Marks

- Duration: The examination shall be of 1 hour duration.

Question Paper Pattern

Theory question paper pattern
1. There shall be two/three questions each of 15/10 marks. 2. All questions shall be compulsory with internal options. 3. Question may be subdivided into sub-questions a, b, c… and the allocation of marks depends on the weightage of the unit.

5. **For 2 Credits Field Project (FP)/Community Engagement Project (CEP) / Research Project (RP) (50 Marks)**

- The performance of the learners shall be evaluated 50 Marks.

Passing Standard

- **1. For 4 or 3 Credits Courses (Discipline Specific Courses (DSC)/Major/Minor Courses):** The learners shall obtain minimum of 40% marks (i.e. 16 out of 40) in the Continuous Internal Assessment (CIA) and 40% marks in Semester End Examination (SEE) (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 Continuous Internal Assessment (CIA) and Semester End Examination (SEE).
- **For 2 Credits Courses AEC, VEC, VSC, SEC, IKS, OE, FP, CEP, RP and CC courses:** Learners should remain present for Continuous Internal Assessment (CIA) and Semester End Examination (SEE)/ Practical Examination (PE). A learner will be said to have passed the course if the learner obtains minimum of 40% marks in the Continuous Internal Assessment (CIA) and Semester End Examination (SEE)/ Practical Examination together and obtain minimum 10 marks out of 30 marks in Semester End Examination (SEE)/ Practical Examination (PE).
- **For Practical Examinations (PE):** The learners shall obtain minimum of 40% marks (i.e. 20 out of 50) in Practical Examination (PE), to pass the course and minimum of Grade D, wherever applicable, to pass a particular semester.

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

- **Rules of A.T.K.T. for Revised NEP 2020 structure of Academic Year 2024-25**

1. A learner shall be allowed to keep term for Semester II irrespective of the number of courses of failure in the Semester I.
2. A learner shall be allowed to take admission to Semester III if he/she passes both Semester I and Semester II.

   OR

   A learner shall be allowed to keep term for Semester III, if he/she fails in not more than four Discipline Specific Courses (DSC) and not more than six other courses of Semester I and Semester II taken together with not more than two Discipline Specific Courses (DSC) and not more than three other courses each in Semester I and Semester II.
3. A learner shall be allowed to keep term for Semester IV irrespective of the number of courses of failure in the Semester III.
4. A learner shall be allowed to take Admission to Semester-V and Keep Terms if he/she Passes in both Semester-I and Semester-II and failed in not more than four Discipline Specific Courses (DSC) and not more than six other courses of Semester – III and Semester – IV taken together with not more than two Discipline Specific Courses (DSC) and not more than three other courses each in Semester – III and Semester – IV

   OR

Passes in both Semester-III and Semester-IV and failed in not more than four Discipline Specific Courses (DSC) and not more than six other courses of Semester – I and Semester – II taken together with not more than two Discipline Specific Courses (DSC) and not more than three other courses each in Semester – I and Semester – II.

5. A learner shall be allowed to keep term for Semester VI irrespective of the number of courses of failure in the Semester V.
6. The result of Semester-VI shall be withheld by the College till the learner passes all the Semesters from I – V.
7. A Learner is allowed to take admission in semester VII (UG Hon. /PG Part I) only if he passed all courses of semesters I to VI (132 Credits).

- **Eligibility Condition to appear for Additional Examination of any Semester (Applicable only for Regular Semester End Examinations)**

A learner who remains absent in some or all the subjects on medical grounds or for representing the College or University in NSS, NCC, Sports, Cultural Activities or co-curricular/extracurricular/extension activities with prior permission of the Principal or Head of the institute reported to the examination section, by producing necessary documents and testimonials, will be allowed to appear for the Additional Semester End Examination (ASEE). This is not applicable for any A.T.K.T. / Supplementary Examinations.

- **Supplementary Examination (SE)**

  The college will conduct supplementary examinations for semester II, IV, and VI after the declaration of their respective results.

Note:

1) It is noted that the concerned regulation of the College is amended and implemented to Semester I to Semester IV of undergraduate programmes, under faculty of Arts, Commerce and Science with effect from the academic year 2024 - 2025.
2) All these rules maybe amended as and when required with authorisation of Academic bodies.

SEMESTER-III

SEMESTER-III

Major Course-5 Biochemistry	
Semester	**III**
Course Name	**Major-5 Biochemistry**
Course Code	**UBT3BIC**
Credit	**03 Theory+01Practical**
Hours/Week	**03 Theory+02 Practical**

Course Objectives-

- To develop fundamentals of Biomolecules and their Biological significance.
- To comprehend the classification, working, Kinetics and functions of the enzymes.

Course Outcomes: After completion of this course students will be able to:

- Explain the Structure, classification, properties and functions of Carbohydrates and lipids.
- Describe the proteins, their structural organization and functions.
- Classify enzymes with Enzyme inhibition.

Units	Course Description	Hrs.
UNIT I : Carbohydrates and Lipids	**Carbohydrates: Classification and functions of Carbohydrates** • Structure, Function, properties and reactions of Monosaccharaides. • Structures and functions of biologically important Disaccharides. • Polysaccharides-Homo and Hetero Polysaccharides, Mucopolysaccharides, Bacterial cell wall poly-saccharides • Glycoproteins and their biological functions. **Lipids: Classification and functions of Lipids** • Classification, nomenclature and properties of fatty acids, essential fatty acids. • Significance of the lipids of Biological Significance-Phospholipids**,** sphingolipids, glycol-lipids, cerebrosides, gangliosides, Prostaglandins and Cholesterol.	15hrs

Unit II: Amino Acids and Proteins	**Amino acids and Protein:** • Classification, Structure and properties of Amino acids. • Classification of proteins: Globular Proteins, Fibrous Protein and Membrane Protein • Functions of Protein. • Forces stabilizing protein structure • Different Level of structural organization of proteins. • Denaturation and renaturation of proteins. • Examples of Proteins • Definition, Nomenclature and classification of Enzymes. Cofactors, coenzyme, prosthetic groups, holoenzyme and apoenzyme.	15hrs
Unit III: **Enzymes**	**Enzymes:** • How do Enzymes work-Concept of activation energy, Lock and Key Model, Induced Fit Model and Substrate strain theory. • Kinetics of enzyme actions- factors affecting enzyme activity. Enzyme kinetics, Km. • Enzymes inhibition – competitive, Non-competitive & uncompetitive inhibition. • An overview of isoenzymes, multienzyme complexes and Allosteric enzymes.	15hrs

Reference Books:

1. Berg, JM Tymoczko, JL. Gatto, GJ. Stryer, L. (2015). Biochemistry. (8th ed.) W H Freeman and Company New York.
2. Nelson DL. Cox MM. (2017) Lehninger Principles of Biochemistry (7th ed.). W H Freeman New York.
3. Voet, D., & Voet, J. G. (2016). Biochemistry (5th ed.). Hoboken, NJ: J. Wiley & Sons.
4. Rodwell VW. Bender D. Botham KM. Kennelly PJ Weil PA. (2018). Harper's illustrated Biochemistry. (31st edition) McGraw-Hill Education
5. Text Book of Biochemistry by Rafi M.D. 3rd edition University press
6. Jain JL. Jain S. Jain N. (2005). Fundamentals of Biochemistry. (6th edition). S Chand and Company Ltd.
7. Satyanarayana U. Chakrapani U. (2013). Biochemistry. (4th edition). Elsevier and Books and Allied (P) Ltd.

Major Course-6 Membrane Biology and Genetics	
Semester	**III**
Course Name	**Major-6 Membrane Biology and Genetics**
Course Code	**UBT3MBG**
Credit	**03 Theory+01Practical**
Hours/Week	**03 Theory+02 Practical**

Course Objectives-

- The objective of this course is to have a firm foundation in the fundamentals of membrane biology and genetics.

Course Outcomes: After completion of this course students will be able to:

- Discuss membrane structure, transport, types and major functions of cytoskeleton.
- Elaborate variation in chromosome structure and number
- Solve problems based on two-point, three-point cross, tetrad analysis, genotypic frequencies and allelic frequencies

Units	Course Description	Hrs.
Unit I Membrane Biology and Cytoskeleton	**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 • Bulk transport: endocytosis and exocytosis **Membrane junctions** • Classification of junctions: Occluding: Tight, Anchoring: Desmosomes, Channel- forming: Gap, Plasmodesmata. **Cytoskeleton** • Microtubules, Microfilaments, Intermediate Filaments: Structure, composition, assembly and disassembly, functions	15h
	Structure and organization of eukaryotic genetic material • Histone and non-histone proteins, Nucleosome structure. • Heterochromatin, Euchromatin, Polytene	15h

Unit II **Genetics**	Chromosomes, Lampbrush chromosome. • Chromosomal banding techniques, Karyotype and Idiogram • Variation in Chromosomal Structure and Number: Deletion, Duplication, Inversion, Translocation, Aneuploidy, Euploidy and Polyploidy • Syndromes- Klinefelter, Turner, Cri-du-Chat, Trisomy-21, Trisomy-18 and Trisomy-13. • Dosage Compensation and Barr body.	
Unit III **Gene Mapping and Population genetics**	**Overview of genetic linkage.** **Gene Mapping in eukaryotes:** • Two-point Cross; Three-point Cross • Pedigree analysis- Dominant and Recessive traits for Autosomal and Sex Chromosome; Tetrad analysis **Population Genetics** • Genetic structure of populations. • Genotypic frequencies and allelic frequencies, • Hardy- Weinberg law and its assumptions	15h

References: -

1. Genetics, (2006) Strickberger MW - (Prentice Hall, India)
2. Human Genetics- A. M. Winchester – MacMillan Press
3. iGenetics- Peter Russell -Pearson Education
4. Cell and Molecular Biology – De Robertis- Lippincott Williams& Wilkins
5. Cell and Molecular Biology- Concepts and Experiments—Karp – Wiley International

Practical Major Course-5 and 6	
Semester	**III**
Course Name	**Practical- Biochemistry (UBT 3BIC) and Membrane Biology and Genetics UBT3MBG**
Course Code	**UBT3PR1**
Credit	**02**
Hours/Week	**04**

Course Objectives-

To develop skillsets in biochemical techniques and solve the problem on genetic mapping.

Course Outcomes: After completion of this course students will be able to:

- Demonstrate different biochemical techniques to analyses biomolecules like proteins, enzymes and lipids etc.
- Solve problems based on two-point, three-point cross, tetrad analysis, genotypic frequencies and allelic frequencies

	Major Practical	**Credits-2**
1.	Estimation of Amino acids by Formal Titration.	
2.	Estimation of reducing sugars by DNSA method.	
3.	Protein estimation by biuret method.	
4.	Isolation of Casein from Milk	
5.	To study the effect of substrate concentration on the activity of the given enzyme.	
6.	To study the effect of pH on the activity of the given enzyme.	
7.	To study the effect of Temperature on the activity of the given enzyme.	
8.	Effect of inhibitors on enzyme activity	
9.	Isolation of Starch from plant source.	
10.	Estimation of starch by Anthrone method.	
11.	Separation of lipids by TLC method.	
12.	Effect of different concentrations of sodium chloride on RBC and determination of the concentration isotonic to blood.	
13.	Study of Polytene Chromosome	
14.	Mapping problems based on tetrad analysis.	
15.	Mapping based on two-point cross and three-point cross.	
16.	Problems based on pedigree analysis- Autosomal and Sex-Linked	
17.	Study of normal karyotype.	
18.	Study of abnormal karyotype: - Klinefelter syndrome, Turner syndrome, Cri-du-	

	Chat syndrome, Trisomy-21, Trisomy-18 and Trisomy-13.
19.	Barr body identification in cells of Buccal smear.
20.	Study of mitosis using pre-treated root tips of *Allium cepa* to study the effect of mutagens- chemical (colchicine/ PDB) on mitosis.

Minor Course-2 Medical Microbiology	
Semester	**III**
Course Name	**Minor -2 Medical Microbiology**
Course Code	**UBT3MEM**
Credit	**02 Theory+02Practical**
Hours/Week	**02 Theory+04Practical**

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

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

- Summarize the factors playing a role in causing a disease.
- Discuss the various aspects of Systemic Infections including Causative Agents, symptoms and Prophylaxis.
- Explain different causative organisms involved in Skin and Respiratory infections GI, STD and Nosocomial infections

Units	Course Description	Hrs.
UNIT I **Medical Microbiology- Causative Organisms- I**	**Infection:** • Factors Affecting the Course of Infection and Disease; Mechanisms of Infection and Virulence Factors. • Types of Infections; Signs and Symptoms; Koch's Postulates. • **Characteristics,** Transmission, Course of Infection, Lab Diagnosis, Prevention and Control • **Skin:** *S. aureus* • **Respiratory Tract Infections:** • *M. tuberculosis, S. pneumonia* • **Urinary Tract Infections:** *E. coli*	15hrs.
UNIT II **Medical Microbiology- Causative Organisms- II**	• **Characteristics, Virulence-** Pathogenesis and Immunity, Clinical Disease, Lab Diagnosis, Prophylaxis and Treatment). • **GI Tract Infections:** *Salmonella and Shigella spps*. • **Sexually Transmitted Diseases:** Syphilis and Gonorrhoea. • **Nosocomial Infections:** *Pseudomonas aeruginosa*	15hrs.

References:

1. Microbiology–6th Edition (2006), Pelczar M.J. Chan E.C.S., Krieg N.R., The McGraw Hill Companies Inc. NY
2. Presscott‘s Microbiology, 8th edition (2010), Joanne M Willey, Joanne Willey, Linda Sherwood, Linda M Sherwood, Christopher J. Woolverton, Chris Woolverton, McGrawHil Science Engineering, USA
3. Text book of Medical Microbiology, Anantnarayan
4. Microbiology- Frobisher
5. General Principles of Microbiology- Stanier
6. Fundamental Principles of Bacteriology - A. J. Salle McGraw Hill.

Minor Course Practical	
Semester	**III**
Course Name	**Practical-Medical Microbiology UBT3MEM**
Course Code	**UBT3PR2**
Credit	**02**
Hours/Week	**04**

Course Objectives: The course aims to teach students how to use different media and tests to find and identify bacteria, and to apply diagnostic tools to study infections.

Course Outcomes :

- Describe how selective and differential media and biochemical tests are used to isolate and identify microorganisms.
- Explain the methods for identifying specific bacteria like *Staphylococcus aureus*, *E. coli*, Salmonella, Shigella, and Pseudomonas using biochemical tests.
- Apply rapid multitest systems and diagnostic tests to identify bacteria and investigate infections, as well as isolate normal microbial flora from the skin.

	Minor-II Medical Microbiology	**Credits-2**
1.	Study of selective and differential media for isolation of microorganisms	
2.	Use of biochemical test (Sugar fermentations, IMViC, Catalase etc.)	
3.	Isolation & Biochemical identification of *S.aureus* -, Catalase, Coagulase Test.	
4.	Biochemical identification of *E. coli*-Sugar Fermentations, IMViC.	
5.	Biochemical identification of *Salmonell*a-Isolation, Sugar Fermentations, TSI Slant.	
6.	Biochemical identification of *Shigella*-Isolation, Sugar Fermentations, TSI Slant.	
7.	Biochemical identification of Pseudomonas - Isolation, Urease test, Oxidase Test, TSI Slant.	
8.	Rapid Multitest Systems - The API 20E System	
9.	Isolation of Normal Microbial flora from the skin	
10.	Widal test	
11.	VDRL Test	
12.	GI Tract Infections: Case study	
13.	Skin Infections: Case study	

14.	Urinary Tract Infections: Case study

Vocational Skill Course-3 Food Biotechnology	
Semester	**III**
Course Name	**Food Biotechnology**
Course Code	**UVSC3FBT**
Credit	**2**
Hours/Week	**60 Hrs**

Course Objective: The course aims to provide students with the skills to analyze and evaluate food quality, detect contaminants and adulterants, prepare value-added food products, and understand food safety and packaging practices.

Course Outcomes:

- Describe the methods used to detect food contaminants, identify food adulterants, and analyze the quality of various food products.
- Explain the processes involved in food spoilage, food packaging, and the determination of shelf life, as well as sensory evaluation techniques.
- Apply laboratory techniques to analyze food samples for proteins, fats, carbohydrates, and other components, and to prepare value-added food products and conduct food safety audits.

Sr. no	Experiment	60 Hours
1	• Biomolecules and function of biomolecules present in food sample: Protein, lipids and carbohydrates • Determination of flour gluten	4hrs
2	• Food spoilage, sources and types of microorganism involved in food spoilage. • Isolation of bacteria and molds from foods; vegetable and fruits/meat/sea foods/ eggs and poultry/ milk and milk products/ sugar, salts and spices/Fermented foods	6hrs
3	• Value added food products • Preparation of value-added Food products (jams, jellies and sauce, Sauerkraut, Kimchi etc.)	4hrs
4	• Food contaminations and its sources in milk or water • Detection of coliforms from milk by MPN method	6hrs
5	• Food adulterations & types of adulterants present in food • Detection of adulterants in different food samples for drug and pesticide residues in milk / milk products/ fruit/ Vegetable/ spices	4 hrs
6	• Food packaging & types of packaging and storage • Shelf-life calculation for food products.	4hrs

7	• Food quality and quality assurance • Food Tests for: presence of moisture content, proteins, starch, carbohydrates, fats (Qualitative) from the given food sample.	3hrs
8	• Analytical method pf food analysis • Determination of fat content in food by Soxhlet method.	5hrs
9	• Sensory evaluation of food and quality indices • Sensory Evaluation of various food products: Hedonic scale, • Dual trio test, Ranking difference and triangle test. Texture evaluation of various food samples (Crispies, cookies, biscuits, snack foods)	8hrs
10	• Food safety and quality evaluation • Quality Evaluation of various food stuffs- cereals, pulses, honey, sugar, tea, coffee	6hrs
11	• Documentation in food safety • Data Preparation for food safety Audit	4hrs
12	• Visit to food processing or food packaging industry.	6hrs

Reference:

1. Deman JM, Principles of Food Chemistry, 2nd ed. Van Nostrand Reinhold, NY 1990.
2. Desrosier NW and Desrosier JN, The Technology of Food Preservation, CBS Publication, New Delhi, 1998.
3. Garbutt, John. Essentials of Food Microbiology, Arnold, London, 1997
4. Marriott, Norman G. Principles of Food Sanitation, AVI, New York, 1985
5. Meilgard (1999). Sensory Evaluation Techniques, 3rd ed. CRC Press LLC, 1999.

SEMESTER IV

Major Course-7 METABOLISM	
Semester	**IV**
Course Name	**Major-7 Metabolism**
Course Code	**UBT4MET**
Credit	**03 Theory+01Practical**
Hours	**03 Theory+02 Practical**

Course Objectives-

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

Course Outcomes: After completion of this course students will be able to:

- Elaborate on the Metabolic Pathways of Carbohydrates, Amino Acids, Lipids and Nucleotides.
- Discuss the Role of Energy Rich Molecules in Metabolism.
- Explain the Protein structure, classification and role of Enzymes as biological catalysts.

Units	Course Description	Hrs.
UNIT I: Carbohydrate Metabolism	Carbohydrates metabolism: • Glycolysis and its regulation • Citric Acid Cycle- Anaplerotic reactions • Gluconeogenesis; Pentose Phosphate Pathway with its significance • Electron Transport and Oxidative Phosphorylation. • Bioenergetics: Law of thermodynamics, ATP as Energy Currency, Structure of ATP, Hydrolysis, Other Energy Rich Compounds other than ATP like PEP, Creatine Phosphate, etc	15Hrs
Unit II: Lipid and Nucleotide Metabolism	• **Lipid Metabolism:** Mobilization, Transport of Fatty Acids. Beta Oxidation of Fatty Acids; Overview of Oxidation of Unsaturated Fatty Acids and Odd Chain Fatty Acids. Ketone body formation • **Nucleotide Metabolism**: Pathways of nucleotide Biosynthesis, Degradation of Purines and Pyrimidines.	15Hrs

Unit III: Amino Acid Metabolism	• **Amino acids and Proteins:** Amino Acid Breakdown: Deamination, Transamination, Urea Cycle, Breakdown of Glucogenic and Ketogenic Amino Acids. Synthesis of essential amino acids, Inborn Errors in Protein Metabolism	15Hrs

Reference Books:

1. D. Voet and J. G. Voet, Biochemistry, J. Wiley & Sons, 2011, 4th
2. D. L. Nelson and M. Cox, Lehninger Principles of Biochemistry, WH Freeman, 2017, 7 th edition
3. J. M. Berg, et. al., Biochemistry, WH Freeman, 2015, 8 th edition
4. H. Lodish, et.al., Molecular Cell Biology, W H Freeman & Co (Sd), 2016, 8 th edition
5. Satyanarayana U. Chakrapani U. (2013). Biochemistry. (4th edition). Elsevier and Books and Allied (P) Ltd
6. Text Book of Biochemistry by Rafi M.D. 3rd edition University press

Major Course-8 Molecular Biology-II	
Semester	**IV**
Course Name	**Major-8 Molecular Biology-II**
Course Code	**UBT4MOB**
Credit	**03 Theory+01Practical**
Hours	**03 Theory+02 Practical**

Course Objectives-

The objective of this course is to provide students with a comprehensive understanding of the fundamental concepts and techniques in molecular biology. To build a firm foundation of molecular biology

Course Outcomes: After completion of this course students will be able to:

- Compare the Prokaryotic and Eukaryotic transcription
- Elaborate Translation and posttranslational events
- Illustrate different types of prokaryotic Operon systems.

Units	Course Description	Hrs.
UNIT I Transcription	• Transcription and RNA processing • RNA structure and types of RNA, • Transcription in prokaryotes: Prokaryotic RNA polymerase, role of sigma factor, promoter, Initiation, elongation and termination of RNA chains. • Overview of Eukaryotic transcription. • Splicing and processing: processing of pre-mRNA: 5' cap formation, polyadenylation, splicing	15h
Unit II Translation	• Genetic code and Wobble Hypothesis. • Protein Synthesis: Translation in Prokaryotes & Eukaryotes- (Formation of aminoacyl tRNA, Initiation, Elongation & Termination of polypeptide). • Post translational Modification of proteins.	15h
Unit III Regulation of gene Expression	• Concept of gene and its organization • Regulation of gene expression: Positive & Negative regulation, The operon model for transcriptional regulation (Lac operon & Trp operon) control of lac operon, regulation of Trp operon. • Recombination-Holliday Model	15h

References

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

Practical Major Course-7 and 8	
Semester	**IV**
Course Name	**Practical - Metabolism (UBT4MET) and Molecular Biology- II (UBT4 MOB)**
Course Code	**UBT4PR1**
Credit	**02**
Hours/Week	**04**

Course Objectives: The course aims to equip students with practical skills and theoretical knowledge in molecular biology techniques and biochemical assays for analyzing and interpreting biological samples and assessing organ function.

Course Outcomes : -

1. Apply molecular biology techniques such as genomic DNA extraction, RNA extraction, and protein estimation to analyze and interpret biological samples.
2. Describe the principles and methodologies of spectrophotometry for determining the purity of DNA, and agarose gel electrophoresis for the separation of nucleic acids.
3. Explain the procedures and significance of various biochemical assays, including organ function tests and enzyme activity measurements, to assess the physiological and pathological states of biological systems.

Sr. No.	**Practical- Major Metabolism**	**Credit 2**
1.	Extraction of genomic DNA from bacteria and Separation by Agarose Gel Electrophoresis	
2.	Determination of Purity of DNA using spectrophotometry	
3.	Extraction of RNA from Prokaryotic/Eukaryotic cells.	
4.	Expression of β-galactosidase and Measurement of Activity.	
5.	Estimation of protein by Lowry's method	
6.	Determination of Total, LDL and HDL Cholesterol in Serum.	
7.	Determination of Lactate Dehydrogenase (LDH) Activity in Blood Serum	
8.	Organ Function Tests: Liver (SGOT)	
9.	Organ Function Tests: Liver (SGPT)	
10.	Organ Function Tests: Kidney (Uric Acid in Urine)	

11.	Organ Function Tests: Kidney (Creatinine in Urine)
12.	Qualitative Detection of Ketone Body in Urine.
13.	Isolation of Mitochondria and Demonstration of ETC using a Marker Enzyme
14.	Separation of Phenylketonuria paper by Paper Chromatography

References:

1. Enzymes: Biochemistry, Biotechnology & Clinical chemistry, (2001) Palmer Trevor, Publisher: Horwood Pub. Co., England.
2. An Introduction to Practical Biochemistry.3rd Edition, (2001), David Plummer, Tata McGraw Hill Edu. Pvt. Ltd. New Delhi, India
3. Advanced Methods in Protein Microsequencing, Witmann
4. Methods in Molecular Biophysics, Igor N S, N Zaccai & J Zaccai, (2007) Cambridge

Minor Course-3 Bioprocess Technology	
Semester	**IV**
Course Name	**Bioprocess Technology**
Course Code	**UBT4BPT**
Credit	**02 Theory+02Practical**
Hours	**02 Theory+04Practical**

Course Objectives:

The course enable student to understand aspects of bioprocess technology encompasses basics skills applied in fermentation technology and build a foundation for more advanced studies in bioprocess technology.

Course Outcomes:

- Explain principles underlying design of Screening, Fermenter and Fermentation Process.
- Summarize In-vivo and In-vitro Assay of Industrial Products.

Units	Course Description	Hrs.
UNIT I **Fermenter and Fermentation Processes**	• **Screening of Strains:** • Primary Screening and Secondary Screening • **Design of a Fermenter:** Stirred Tank Fermenter- Basic Design; Parts of a Typical Industrial Fermenter • **Fermentation Media:** Components; Design and Optimization. • **Process Parameters:** pH, Temperature, Aeration, Agitation, Foam • **Types of Fermentation:** Surface and Submerged; Batch and Continuous, Aerobic and Anaerobic	15
UNIT II **In-vivo and In-vitro Assay of Industrial Products**	• **Product Isolation and Purification**. Outline of Penicillin and Ethanol Production by Fermentation along with flow diagram • **Assay of Industrial Products:** Physical-Chemical and Biological; Types and Subtypes; Kinetics Half-Life Determination of Pharmacological Products • **Overview of Bioavailability and Bioequivalence Studies:** History of Bioavailability Studies, Formulations and	15

	Routes of Administration, Study of Bioequivalence Studies	

Reference Books:

1. Principles of Fermentation Technology by Peter F Stanbury, Allan Whitaker and Stephen J Hall (2nd Edition)
2. Industrial Microbiology- A. H. Patel
3. Industrial Microbiology- L. E. Casida- John Wiley & Sons
4. Microbiology- Frobisher Design and Analysis of Bioavailability and Bioequivalence Studies by Shein-Chung Chow, Jen-pei Liu (3rd Edition)

Minor Course-3 Practical	
Semester	**IV**
Course Name	**Practical -Bioprocess Technology (UBT4BPT)**
Course Code	**UBT4PR2**
Credit	**02**
Hours	**04**

Course Objectives:

- The course aims to provide students with practical skills and theoretical understanding of microbial growth patterns, fermentation processes, antibiotic production, and the isolation and characterization of beneficial microorganisms, equipping them for applications in industrial microbiology and biotechnology.

Course Outcomes:

- Apply microbiological and biochemical techniques to study microbial growth patterns, screen for antibiotic-producing strains, and produce and purify ethanol on a lab scale.
- Describe the processes of microbial fermentation, including the lab-scale production and purification of ethanol, and the estimation of alcohol and penicillin concentrations from broth cultures.
- Explain the principles behind the isolation and characterization of lactic acid bacteria from probiotic foods and the significance of these techniques in industrial microbiology and biotechnology.

Sr. No.	**Bioprocess technology (Practicals)**	**30 Hrs.**
1.	Study of *E. coli* diauxic Growth Curve- (Lactose and Glucose).	4 hrs.
2.	Screening for an Antibiotic Producing Strain of Microorganism	8 hrs.
3.	Lab Scale Production of Ethanol.	4 hrs.
4.	Purification of Ethanol from Broth Culture of Saccharomyces spp. By Distillation	3 hrs.
5.	Estimation of Alcohol from Recovered Broth by Dichromate Method.	4 hrs.
6.	Estimation of Penicillin from Recovered Broth by Biological (Bioassay) Method.	4 hrs.
7.	Isolation of lactic acid bacteria from Probiotic foods.	3 hrs.

Skill Enhancement Course-3	
Semester	**IV**
Course Name	**Practical-Bioanalytical techniques**
Course Code	**USEC4BTE**
Credit	**02**
Hours	**60 hours**

Course Objectives: -

- Explore a variety of bioanalytical techniques, such as chromatography, spectroscopy (UV-Vis), electrophoresis, and immunoassays etc.
- Acquire hands-on experience in sample preparation, instrument operation, and data analysis for bioanalytical methods.

Course Outcomes:

After completion of this course students will be able to:

- Acquire hands-on experience in sample preparation, instrument operation, and data analysis for bioanalytical methods.
- Apply bioanalytical techniques to the analysis of biological molecules such as proteins, nucleic acids, lipids, and metabolites.
- Develop skills in interpreting complex data obtained from bioanalytical experiments.
- Gain a solid understanding of the fundamental principles and concepts underlying bioanalytical techniques.

Sr. No.	Title
1.	Study of different Isolation techniques of Biomolecule. Isolation of proteins from plant source/ bacterial source
2.	Study of different separation technique Centrifugation and types of centrifugations, types of rotors Separation of cell organelles using density gradient method / Isopycnic method
3.	Separation and partial purification by salt precipitation method of proteins Extraction and partial purification of proteins/ enzymes (Amylase) followed by dialysis.
4.	Study of different types of chromatographic techniques Separation of different plant pigment by Thin Layer Chromatography
5.	Study the extraction of lipids/ fats from solid material Electrophoresis Demonstration of Soxhlet Apparatus

6.	Study the different electrophoretic separation techniques Separation of proteins by using serum electrophoresis
7.	Study the different paper electrophoretic separation techniques Separation of biomolecules by using paper electrophoresis like Hemoglobin/ Amini acid.
8.	Study the immunological techniques to study the interaction between antigen and antibodies Ouchterlony method
9.	To study on viscosity on liquids Viscosity study of protein
10.	Study the Principle and instrumentation of HPLC Qualitative analysis of caffein in given sample by using HPLC
11.	Study the Principle and Instrumentation of Gas Chromatography Study the separation of volatile compounds from a mixture by using Gas chromatography

II विद्या विनयेन शोभते॥

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

Program: Bachelors in Science (T.Y. B. Sc.)

Credits: 44 (Semester V and VI)

SYLLABUS
(Approved in the Academic council meeting held on 13/06/2024)

B. Sc. Biotechnology

Revised as per Choice Based Credit System (60:40) w. e. f. Academic Year 2024-25

Department of Biotechnology

T.Y. B.Sc. Biotechnology Course Structure

(Semester V)

Course code	Title	Theory/ Practical	Marks	Credits	No. of Lectures & Practical
UBT5CBI	Cell biology and ATC	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 and Developmental Biology	Theory	100	2.5	60
UBT5PR1	Cell biology+ Medical Microbiology & Instrumentation	Practical	100	3.0	72
UBT5PR2	Genomes and Molecular Biology+ Marine Biotechnology and Developmental Biology	Practical	100	3.0	72
UBT5BIS	Applied Component: Biosafety	Theory	100	2.0	48
UBT5PR3	Applied Component: Biosafety	Practical	100	2.0	48
UBT5HDP	Hydroponics	Theory	100	2.0	48
		TOTAL	**800**	**22**	**528**

(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
UBT6FSC	Forensic Science	Theory	100	2.0	48
		TOTAL	**800**	**22**	**528**

Department of Biotechnology

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.

Department of Biotechnology

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:

- 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 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.

Department of Biotechnology

BACHELOR'S IN SCIENCE (B. Sc.)

Programme Outcomes

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.

Department of Biotechnology

Scheme of Examination (Amended)
Faculty of Science
(Under-graduate Programmes)

Choice Based Credit System (CBCS)

❖ **Revised Scheme of Examination**

1. For 4 or 3 Credits Courses (Discipline Specific Courses (DSC)/Major/Minor Courses) (100 Marks)

The performance of the learners shall be evaluated into two components, as the first component by 'Continuous Internal Assessment (CIA)' with 40% marks and as the second component by conducting the 'Semester End Examinations (SEE)' with 60% marks. The allocation of marks for the Continuous Internal Assessment (CIA) and Semester End Examinations are as shown below:

A) Continuous Internal Assessment (CIA): 40 % 40 Marks

Sr. No.	Particular	Marks
01	One periodical class test / online examination to be conducted in the given semester	20 Marks
02	Test on Practical Skills/ Case studies /Group/ Individual Survey Project/Presentation and write up on the selected topics of the subjects/ Book Review / Open Book Test	15 Marks
03	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibition of leadership qualities in organizing related academic activities	05 Marks

Question Paper Pattern (Periodical Class Test)

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/True or False/ 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 (SEE): 60 % 60 Marks

- Duration: The examination shall be of 2 hours duration.

Question Paper Pattern

Theory question paper pattern
1. There shall be three/four questions each of 20/15 marks. 2. All questions shall be compulsory with internal options. 3. Question may be subdivided into sub-questions a, b, c… and the allocation of marks depends on the weightage of the unit.

- **Practical Examination (PE) for Discipline Specific Courses (DSC) / Minor Courses 50 Marks**

  The Practical Examination (PE) shall be of 50 marks for Discipline Specific Courses (DSC)/Minor Courses.

- **Practical Examination (PE) for Major Courses (Semester III & Semester IV) 100 Marks**

  The Practical Examination (PE) shall be of 100 marks for Major Courses of Semester III & Semester IV.

B) Semester End Examination (SEE): 60 % 30 Marks

- Duration: The examination shall be of 1 hour duration.

Question Paper Pattern

Theory question paper pattern
1.There shall be two/three questions each of 15/10 marks. 2.All questions shall be compulsory with internal options. 3. Question may be subdivided into sub-questions a, b, c… and the allocation of marks depends on the weightage of the unit.

SEMESTER -V

Department of Biotechnology

Course Description	
Semester	**V**
Course Name	**Paper-I (Cell Biology and Animal Tissue Culture)**
Course Code	**UBT5CBA**
Credit	**2.5**
Hours	**60 Hrs.**

Course Objectives: After Completion of this course:	
•	Students will get knowledge of different types of extracellular signals and receptors, and explain their functional significance.
•	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
•	Students will get introduced to the principles and applications of animal cell culture.
•	Students will be able to illustrate different types of Animal Tissue Culture Techniques

Course Outcomes: After completion of the course students will be able to	
CO-1	Discuss the major groups of intracellular-and membrane-bound receptors, be able to give examples of such receptors.
CO-2	Explain different types of cancer, its diagnosis, treatment and preventive measures.
CO-3	Describe design, layout of ATC Lab along with equipment used in tissue culture.
CO-4	Identify media constituents and media formulation strategies and techniques for mammalian cell culture.

	Course Description	**Lectures**
Unit I **Cell Signaling**	• Cell signaling and signal transduction: Introduction General Principles of Cell Signaling. • 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.	**15h**

Unit II **Cancer Biology**	• Introduction to cancer, Characteristics of normal cell and cancerous cell, Tumour- Benign and malignant. • Types of cancer • Cancer as a Micro-evolutionary Process, invasion metastasis, angiogenesis. • Oncogenes and tumour suppressor genes; The Molecular Genetics of Cancer. • Cancer and Virus, Cancer diagnosis and treatment, Preventive measures for cancer.	**15h**
Unit III **ATC-I**	• Introduction to tissue culture. • Advantages and limitations. Application of tissue culture • Design and layout: Sterile handling area, incubation, hot room, service bench, preparation, storage. • Equipment, glassware and Sterilization: Bio safety Cabinet, CO2 incubator, inverted microscope etc. Glassware, plastic ware, pipetting device, tissue culture vessels	**15h**
Unit IV **ATC-II**	• Tissue culture media • Physiochemical properties, Balance Salt Solution, complete media, Serum, Serum Free Medium- Advantages and Disadvantages • Types of cell culture: • Organ culture, primary cultures and cell lines with examples, Stem cell cultures - therapeutic cloning, carcinoma stem cells, germ cell culture, and uses.	**15h**

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.

Department of Biotechnology

Course Description	
Semester	**V**
Course Name	**Paper II (Medical Microbiology & Instrumentation)**
Course Code	**UBT5MMI**
Credit	**2.5**
Hours	**60 Hrs.**

Course Objectives: After Completion of this course:	
•	The students will get knowledge of viral replication strategies; and compare and contrast replication mechanisms used by viruses relevant for human disease.
•	Students will learn the mechanism of action of chemotherapeutic drugs and resistance.
•	Students will learn about new emerging diseases and new vaccine strategies.
•	Students will be able to apply basic principles and applications of analytical techniques used.

Course Outcomes: After completion of the course students will be able to:	
CO-1	Compare and contrast replication mechanisms used by viruses along with their cultivation, purification techniques. Compare and apply different separation techniques & use them in research work
CO-2	Identify various common and new emerging diseases of humans, different diagnostic techniques and various methods involved in infection control.
CO-3	Describe the mechanism of action of different antimicrobial agents and analyse the importance of appropriate drug therapy by learning the mechanisms of development of drug resistance.
CO-4	State the role of different types of vaccines in their prevention

	Course Description	Lectures
Unit I 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	**15h**

Unit II **Virology and Vaccines**	• Bacteriophage Life Cycle, • Regulation of phage gene expression. Animal viruses and plant (TMV)virus; • Virus purification and assays; Cytocidal infections and cell damage ,Viroids and Prions; • Vaccine Subunit Vaccines -HSV, Peptide Vaccines, Attenuated Vaccines-Cholera, Vector Vaccines-Vaccinia virus, • Genetic Immunization	**15h**
Unit III **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 • Aminoglycoside, Tetracycline, Chloramphenicol, • Macrolides and 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 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, Scintillationcounter, Autoradiography, Applications of tracer techniques in Biology.	**15h**

References:

1.	Principles and techniques in biochemistry and molecular biology (2010), Keith Wilson and John Walker, 7th edition, Cambridge University Press.
2.	Biophysics (2002) Vasantha Pattabhi 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. A 18^{th} edition. Medical Microbiology by Patrick Murray 5^{th} edition.
7.	Foundations in Microbiology by Talaro and Talaro Third edition W.C Brown Understanding Viruses by Teri Shors

Department of Biotechnology

Course Description	
Semester	**V**
Course Name	**Paper III (Genomes and Molecular Biology)**
Course Code	**UBT5GMB**
Credit	**2.5**
Hours	**60 Hrs.**

Course Objectives: After Completion of this course:	
•	Students will learn different techniques involved for the genetic engineering of plants as well as Pros and cons of GM crops
•	Students will get knowledge of animal genetic engineering and its application for livestock improvements for human welfare
•	Students will get insights of working principles of molecular biology techniques
•	Students will be able to conclude prokaryotic gene editing and regulating techniques.

Course Outcomes: After completion of the course students will be able to	
CO-1	Elaborate on the gene transfer methods in plants by physical, chemical methods as well as plasmid derived vector systems.
CO-2	Summarize the animal transfection methods and applications of transgenic animals
CO-3	Explain tools and techniques used in molecular biology
CO-4	Discuss various gene editing methods and regulations of prokaryotic gene

	Course Description	Hrs
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, PEG and calcium phosphate mediated gene transfer. • Viral Vectors for plant cells transformation brief introduction. • GM Crops: BT Cotton, BT Brinjal, • Golden Rice, Pros. and Cons. of these GM crops.	**15h**

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 livestock by nuclear transfer. • Animal models	**15h**
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	**15h**
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)	**15h**

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)

Department of Biotechnology

Course Description	
Semester	**V**
Course Name	**Paper IV (Marine Biotechnology and Developmental Biology)**
Course Code	**UBT5MBI**
Credit	**2.5**
Hours	**60 Hrs.**

Course Objectives: After Completion of this course:	
•	Students will learn methodological approaches that are currently being used for microbial bio- prospecting, with emphasis in the marine environment.
•	Students will learn the development and utilization of marine-derived bioproducts and biomaterials, including applications in medicine, industry, and materials science.
•	Students will get knowledge of developmental biology which includes stages, mechanisms and patterns of embryonic development.
•	Students will get knowledge of plant developmental biology and stem cell biology.

Course Outcomes: After completion of the course students will be able to	
CO-1	Apply knowledge of marine ecosystems and the principles of biotechnology, the importance of biotechnology in exploring and conserving marine biodiversity
CO-2	Identify and evaluate specific marine biotechnological applications, demonstrating their understanding of the real-world uses and implications of biotechnology in marine-related industries and research.
CO-3	Elaborate the stages of animal development & mechanism of differentiation.
CO-4	Discuss the features and stages of plant development with model organism & Stem cell biology

	Course Description	**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	**15h**

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. • Fishery by-products-Fish Meal, Fish Oils, Fish Silage, Fish gelatin, Fish calcium, • Chitin & Chitosan, Hydroxyapatite.	**15h**
Unit III 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.	**15h**
Unit IV 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.	**15h**

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.	Developmental biology Barresi, Scott F. Gilbert

Department of Biotechnology

Course Description	
Semester	**V**
Course Name	**Paper V: Applied Component (Biosafety)**
Course Code	**UBT5BIS**
Credit	**2.5**
Hours	**60 Hrs.**

Course Objectives: After Completion of this course:	
•	Students will be acquainted with the fundamental concept of biosafety and regulations in Biotechnology laboratory.
•	Students will be familiar with different competent authorities and its role in regulations of GMO and LMO.
•	Students will understand how to detect potential contamination risks or products.
•	Students will be able to develop the concepts of biosafety in Biotechnology.

Course Outcomes: After completion of the course students will be able to	
CO-1	Develop an understanding about Biosafety, Biological risk assessment and Hazardous Characteristics of an Agent.
CO-2	Explain an overview regarding regulatory biosafety guidelines and various roles of competent authorities.
CO-3	Apply Microbiological testing in pharmaceuticals & common microbial contaminants.
CO-4	Explain the concepts of biosafety in biotechnology and its regulations

	Course Description	**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	**15h**
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	**15h**

	agriculture; • Environmental release of GMOs; • Risk Analysis, Risk Assessment and Risk management.	
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.	**15h**
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 Labelling of Genetically Modified Foods. • Concerns aboutthe Impact of Genetically Modified Organisms on the Environment.	**15h**

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.

Department of Biotechnology

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

1. Preparation and sterilization of different types of cell culture media i.e. RPMI 1640, Balanced Salt solutions
2. To isolate lymphocytes from whole blood by gradient centrifugation
3. Isolation and culture of animal cell.
4. To check cell viability by cell counting
5. Demonstration: Principle, working and applications of FTIR.
6. Permanent slide of the cancer cells.
7. MIC and MLC of any one antibiotic
8. Antibiotic sensitivity test using agar cup method
9. Antibiotic sensitivity test using paper disc method
10. Antibiotic sensitivity test using ditch method.
11. Synergistic Action of two drugs
12. Preparation of TAB vaccine.

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	SEMESTER V	
Course Code	**Title**	**Credits**
UBT5PR2	**Practical 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. Gradient plate technique
6. Formulation of Fish Feed using Ingredients from Plant Sources.
7. DPPH assay for antioxidant extracted from marine algae
8. Extraction of carotenoids from marine algae/Bacteria/Fungi.
9. Extraction of Gelatin from marine sources.
10. Estimation of gelatin.
11. Extraction and estimation of Collagen from marine sources.
12. Study of permanent slides/photographs related to plant development.

	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 chemicals etc.
6. Sterile testing methods for pharmaceutical products.
7. Isolation of pathogenic bacteria from fomites on operating room of pharmaceutical industry/ Packaging material of pharmaceutical products 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.

Department of Biotechnology

Course Description-	
Semester	**V**
Course Name	**SEC3 – Hydroponics**
Course Code	**UBT5HDP**
Credit	**02**

Course Objectives- Course Objectives: After Completion of this course:
Students will be able to explain basics concepts and science behind hydroponics

Course Outcomes: After completion of this course students will be able to:

- Design hydroponic system suitable for different types of plants
- Evaluate the cost effectiveness and potential profitability of hydroponics

Units	Course Description	Hrs.
Unit I Introduction to Hydroponic	• Hydroponic production – Basic principles, Historical Perspectives, Advantages/Disadvantages, • Types of Hydroponics Systems • Growing Substrates • Plant Nutrition, Nutrient Solution and System Monitoring: EC, pH, • Aerial Environmental Factors and Plant Growth: Light, Temperature, CO_2, RH, Cooling Systems • Organic hydroponics	**15**
Unit II Management of Hydroponics	• Design of hydroponic growing system • Management of commercial hydroponic farming • Hydroponics Systems in leafy greens: Lettuce • Hydroponics Systems in vine crops: tomatoes	**15**

References:

1. J. Benton Jones, Jr: Complete Guide for Growing Plants Hydroponically CRC Press.
2.
3. Hydroponics Farming Technology- A Skilling Program Training Manual Department of Agriculture Ministry of Agriculture and Forests Royal Government of Bhutan March 2021

SEMESTER -VI

Department of Biotechnology

Course Description	
Semester	**VI**
Course Name	**Paper I (Biochemistry)**
Course Code	**UBT6BIC**
Credit	**2.5**
Hours	**60 Hrs.**

Course Objectives: After Completion of this course:	
•	Understand the quaternary protein ligand interactions, protein folding and degradation.
•	Correlate biosynthetic pathways and regulation
•	Learn the various functioning of endocrine gland secretions with their associated disorders.

Course Outcomes: After completion of the course students will be able to :	
CO1	Justify protein structure and protein-ligand interactions and Apply different protein purification techniques.
CO2	Analyze the metabolism of carbohydrates and fates of various intermediate and end product.
CO3	Classify hormones with their functions.
CO4	Identify hormone associated disorders.

	Course Description	Hrs.
Unit-I Protein Biochemistry	Quaternary structure of proteins with special reference to Hemoglobin, cooperative oxygen binding and concerted 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.	**15h**
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.	**15h**

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 Thyroid hormones: Biosynthesis, Biochemical and physiological functions, disorders and thyroid function tests. Chemistry, Biochemical and physiological functions of androgens, estrogens and progesterone. Hormonal regulation of menstrual cycle, Hormonal contraception.	**15h**
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 Catecholamine. Hormones of pancreas: structure, biochemical and physiological functions and disorders: Insulin and glucagon. Diabetes mellitus. Recombinant Insulin.	**15h**

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

Department of Biotechnology

Course Description	
Semester	**VI**
Course Name	**Paper II (Industrial Microbiology)**
Course Code	**UBT6IMI**
Credit	**2.5**
Hours	**60 Hrs.**

Course Objectives: After Completion of this course:	
•	Students will learn the production outline of various dairy products.
•	Students will learn the different modes of fermentation.
•	Learn outline of Down-streaming processing and understand various methods applied in solvent recovery, cell disruption & separation.
•	Students will understand the Standard operating procedures, GMP and QA and QC.

Course Outcomes: After completion of the course students will be able to :	
CO1	Explain different productions in dairy industry
CO2	Elaborate on bacterial and fungal inoculum development
CO3	Formulate protocol of Down-streaming processing and understand various methods applied in solvent recovery, cell disruption & separation.
CO4	Design requirements of QA-QC along with various documentation & Audit reports

At the end of the course, students will be able to:

	Course Description	Hrs
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.	**15h**
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	**15h**

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	**15h**
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.	**15h**

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

Department of Biotechnology

Course Description	
Semester	**VI**
Course Name	**Paper III (Pharmacology and Neurochemistry)**
Course Code	**UBT6PNE**
Credit	**2.5**
Hours	**60 Hrs.**

Course Objectives: After Completion of this course: Students will learn	
•	The mechanism of drug action and its dose–response relationship along with the drug delivery and action in the body.
•	In depth knowledge on toxic substances and poisons ie. Toxicology.
•	The properties of cells that make up the nervous system including the propagation of electrical signals used for cellular communication.

Course Outcomes: After completion of the course students will be able to :	
CO1	Summarize the basic concept of mechanism of drug action.
CO2	Elaborate drugs and their poisonous effect if the administered for longer period of time.
CO3	Outline the basic concept of toxicology and their types.
CO4	Explain the basic neurochemistry and action of specific drugs on the Central Nervous System.

	Course Description	Hrs
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.	**15h**

Unit-II Drug Absorption Distribution Metabolism and Excretion	Absorption of drugs from the alimentary tract; 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.	**15h**
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.	**15h**
Unit-IV Neurochemist ry	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 Neurodegenerative Disorders, Antiepileptic Drugs.	**15h**

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 Ramasamy Raveendran: Introduction to Basics of Pharmacology and Toxicology, Volume 1: General and Molecular Pharmacology: Principles of Drug Action springer.

Department of Biotechnology

Course Description	
Semester	**VI**
Course Name	**Paper IV- (Environmental Biotechnology)**
Course Code	**UBT6ENB**
Credit	**2.5**
Hours	**60 Hrs.**

Course Objectives: After Completion of this course: Students will learn	
•	The concepts of solar energy, wind power, geothermal energy and hydropower, biomass energy, Biogas technology and Biofuels.
•	The techniques and strategies of Industrial effluent treatment and waste water management
•	Exposed to the processes which are currently associated and taking place in industry along with their consequences on generation of hazardous waste.

Course Outcomes: After completion of the course students will be able to :	
CO1	Apply renewable energy sources for both domestics and industrial application.
CO2	Explain the current applications of biotechnology to environmental quality evaluation, monitoring and remediation of contaminated environments.
CO3	Identify the most common techniques for preventing, minimizing, recycling, disposing and treatment of waste and their application on site remediation.
CO4	Discuss various treatment methodologies for hazardous waste management.

	Course Description	Hrs
Unit-I **Natural Resources and Disaster Management**	Renewable and Non-renewable resources: Natural resources and associated problems: Forest resource, Water resource, mineral resource, food resource, Energy resource and Land resource. Concept of sustainable development. Strategy for sustainable development. Ecotourism. Disaster Management: Components of Disaster Management, Government's Role in Disaster Management through Control of Information, Actors in Disaster Management, Organizing Relief measures at National and Local Level. Epidemiological Issues: Fluorosis, Arsenocosis, Goitre, Dengue	**15h**

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 Biodegradation of xenobiotics- persistent compounds, chemical properties influencing biodegradability, microorganisms in biodegradation. Use of immobilized enzymes or microbial cells for treatment.	**15h**
Unit-III Solid waste treatment and Biosensors	Solid waste treatment: Green Manure, Bio- compost making methods Types and methods of vermicomposting, field applications. Pollution indicators Biosensors: Introduction; General configuration of biosensor; Generations of biosensors; Basic principle and instrumentation of different biosensors: electrochemical, optical, acoustic, piezoelectric, and calorimetric biosensors; Biological recognition systems: enzyme, antibody, nucleic acid, cell, and tissue	**15h**
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	**15h**

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) Indu Shekar Thakur IK International
4	Environmental Biotechnology (Industrial pollution management) S.N. Jogdand, Himalaya Publishing House

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Course Description	
Semester	**VI**
Course Name	**Paper V (Applied Component: Agribiotechnology)**
Course Code	**UBT6ABT**
Credit	**2.5**
Hours	**60 Hrs.**

Course Objectives: After Completion of this course:	
•	Students will be exposed to technology and the techniques that can be used to improve the efficiency of agricultural operations like greenhouse technology.
•	Students will develop knowledge crop improvement methods.
•	They will gain the knowledge of different markers used in plant breeding techniques
•	Students will gain concept of bio-fertilizers, Symbiotic-Non symbiotic nitrogen fixation in leguminous plant, assimilation of phosphorus and biopesticides.

Course Outcomes: After completion of the course students will be able to :	
CO1	Apply greenhouse technology.
CO2	Explain the methods of plant improvement and use of microbes as bio-fertilizers, PGPRs, bio-pesticides, Microbial Inoculants
CO3	Apply Inoculant formulations, biocontrol and Polymicrobial Inoculant Formulations.
CO4	Discuss genetic and molecular markers in plant breeding.

	Course Description	**Hrs**
Unit-I Precision Agriculture and Agriculture system	Introduction to Agriculture and agriculture systems Greenhouse Technology-- Types of greenhouse importance, functions and features of greenhouse, Design criteria and calculations. Construction material, covering material and its characteristics growing media, greenhouse 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.	**15h**

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. Hydroponics: an overview of techniques and media used.	**15h**
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	**15h**
Unit-IV Bio-fertilizers and Bio-pesticides	Bio-fertilizer: Nitrogen-fixing Rhizobacteria – Symbiotic Nitrogen Fixers and Nonsymbiotic Nitrogen Fixers. Plant Growth Promoting Microorganisms Phosphate- Solubilizing Microbes (PSM). Plant Growth Promotion by Fungi--Mycorrhizae Arbuscular Mycorrhizae Ectomycorrhizae. 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).	**15h**

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.

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

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

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	SEMESTER VI	
Course Code	**Title**	**Credits**
UBT6PR3	**Practical of Applied component: Agribiotechnology**	**2.0**

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

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