(Scheme UG A4: (Interdisciplinary)

Semester 1

Course Code	Course Title	Course ID	L	T	P	L	T	P	Total Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
Core Course(s)														
CC-ID1	Fundamentals of Genetics	250/BIOT/CC101	3	-	2	3	-	1	4	25	50	5	20	100
CC-ID2	Basic Cell Biology	250/BIOT/CC102	3	-	2	3	-	1	4	25	50	5	20	100
CC-ID3	Basics of Biomolecules	250/BIOT/CC103	3	-	2	3	-	1	4	25	50	5	20	100

Semester 2

Course Code	Course Title	Course ID	L	T	P	L	T	P	Total Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
Core Course(s)														
CC-ID4	General Microbiology	250/BIOT/CC 201	3	-	2	3	-	1	4	25	50	5	20	100
CC-ID5	Cellular Metabolism	250/BIOT/CC 202	3	-	2	3	-	1	4	25	50	5	20	100
CC-ID6	Basics of Molecular Biology	250/BIOT/CC 203	3	-	2	3	-	1	4	25	50	5	20	100

Semester 3

Course Code	Course Title	Course ID	L (Hrs)	T (Hrs)	P (Hrs)	L Credits	T Credits	P Credits	Total Credits	MARKS TI	MARKS TE	MARKS PI	MARKS PE	MARKS Total
Core Course(s)														
CC-ID7	Bioanalytical Tools	250/BIOT/CC301	3	-	2	3	-	1	4	25	50	5	20	100
CC-ID8	Fundamentals of Immunology	250/BIOT/CC302	3	-	2	3	-	1	4	25	50	5	20	100
CC-ID9	Basic Enzymology	250/BIOT/CC303	2	-	2	2	-	1	3	15	35	5	20	75

Semester 4

Course Code	Course Title	Course ID	L (Hrs)	T (Hrs)	P (Hrs)	L Credits	T Credits	P Credits	Total Credits	MARKS TI	MARKS TE	MARKS PI	MARKS PE	MARKS Total
Core Course(s)														
CC-ID10	Basics of Recombinant DNA Technology	250/BIOT/CC401	3	-	2	3	-	1	4	25	50	5	20	100
CC-ID11	Introduction to Medical Microbiology	250/BIOT/CC402	3	-	2	3	-	1	4	25	50	5	20	100

CC-ID12	Introduction to Animal Biotechnology	250/BIOT/CC403	3	-	2	3	-	1	4	25	50	5	20	100

Internship is to be done during summer break after 4th semester, Marks will be added in 5th Semester.

Semester 5

Course Code	Course Title	Course ID	L	T	P	L	T	P	Total Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
Core Course(s)														
CC-ID13	Introduction to Bioinformatics	250/BIOT/CC501	3	-	2	3	-	1	4	25	50	5	20	100
CC-ID14	Fundamentals of Genomics and Proteomics	250/BIOT/CC502	3	-	2	3	-	1	4	25	50	5	20	100
CC-ID15	Introduction of Environment Biotechnology	250/BIOT/CC503	3	-	2	3	-	1	4	25	50	5	20	100

Semester 6

Course Code	Course Title	Course ID	L	T	P	L	T	P	Total Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
Core Course(s)														

CC-ID16	Introduction to Plant Biotechnology	250/BIOT/CC601	3	-	2	3	-	1	4	25	50	5	20	100
CC-ID17	Bioprocess Technology	250/BIOT/CC602	2	-	4	2	-	2	4	15	35	15	35	100
CC-ID18	Bioethics, IPR & Enterpreneurs-hip	250/BIOT/CC603	2	-	2	2	-	1	3	15	35	5	20	75

Semester 7; 8 (Honours) and Semester 8 (Honours with Research): Detailed Scheme will be prepared in due course of time.

UG PROGRAMME (INTERDISCIPLINARY)

B.Sc Biotechnology 1st Sem

Part A - Introduction	
Semester	I
Name of the Course ID1: 250/BIOT/CC101	Fundamentals of GENETICS
Course Learning Outcomes (CLO): After completing this course, the learner will be able to: 1. Appreciate the historical developments that have shaped the field of genetics. 2. Understand the principles of inheritance as formulated by Mendel and the correlation of these principles with the behavior of chromosomes during meiosis. 3. Develop a critical understanding of allelic and non-allelic interactions, sex-linked transmission, polygenic and extranuclear inheritance	

4. Understand the organization of prokaryotic and eukaryotic genomes and the effect of chromosomal abnormalities leading to genetic disorders.
5. Apply the concepts of genetic linkage and crossing for calculating gene distances and generating genetic maps.
6. Apply the Hardy-Weinberg Law in the context of population genetics.
7. Develop analytical skills and critical thinking through pedigree analysis and solving numerical based on theoretical concepts.

Credits	**Theory**	**Practical**	**Total**
	3	1	4
Contact Hours	3	2	5
Max. Marks:100 **Internal Assessment Marks: 30** (25 Theory + 05 Practical) **End Term Exam Marks: 70** (50 Theory + 20 Practical)	**Time: 2h (Theory), 2h (Practical)**		

Part B- Contents of the Course

Instructions for Paper-Setter

Nine questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining eight questions will be set taking two questions from each unit. The candidates will be required to attempt Q.No.1 & four others selecting one question from each unit. All questions carry equal marks.

UNIT I	**CONTACT HOURS**
Genetics - Definition, history, and terminology **Mendelian genetics**: Mendel's work on transmission of traits, Principles of Inheritance, monohybrid, di-hybrid, and trihybrid crosses, test cross, backcross, Chromosome theory of inheritance (Sutton-Boveri) and its relation to cell division **Extensions of Mendel's Principles**: **Allelic interactions:** Incomplete and codominance, multiple alleles, pseudo alleles, essential and lethal genes, pleiotropy, penetrance, and expressivity. **Non-allelic**	**14**

interactions: Complementary gene interaction; Dominant and Recessive Epistasis; Duplicate gene Interactions; Inhibitory gene interactions. **Polygenic traits**- quantitative inheritance (human skin colour)	
UNIT II **Linkage, Crossing Over, and Chromosomal Mapping** **Linkage**: Chromosome theory of linkage, types of linkage, linkage groups, factors affecting linkage and significance of linkage **Crossing Over**: Types of crossing over, Molecular mechanism of crossing over, cytological basis of crossing over, factors affecting and significance of Crossing over **Chromosomal Mapping**: Recombination frequency as a measure of linkage intensity, two-factor and three-factor crosses, determination of map distance, determination of gene order, Interference and coincidence. **Sex determination and sex linkage:** Mechanisms of sex determination, genic balance theory, Environmental factors and sex determination, Barr bodies, dosage compensation, inheritance of Sex-linked, Sex-influenced, and Sex-limited characters	**10**
UNIT III **Chromosome and genomic organization:** Organization of prokaryotic, viral, and eukaryotic nuclear genome, packaging of DNA molecule into chromosomes, chromosome morphology, chromosome types, concept of euchromatin and heterochromatin (constitutive and facultative), Special types of chromosomes- Polytene chromosomes and Lampbrush Chromosomes, Chromosome banding pattern and Karyotype. **Chromosomal aberrations: Structural** aberrations (Deletions, Duplications, Inversions & Translocations-reciprocal and Robertsonian), Position effects of gene expression, **Numerical** aberrations (Euploidy and Aneuploidy).	**14**
UNIT IV	

Extrachromosomal Inheritance Characteristics of extranuclear inheritance, Chloroplast mutation/Variegation in Four o' clock plant and *Chlymodomonas*. Mitochondrial mutations in *Neurospora* and yeast, Maternal effects- snail shell coiling, Infective heredity- Kappa particles in *Paramecium*. Genomic imprinting **Population Genetics**: Allele frequencies, Genotype frequencies, Hardy-Weinberg Law and its application for calculating allelic and genotype frequencies, exceptions to the Hardy-Weinberg principle.	7
List of Practical: 1. Study of Mendelian Traits: Straight hair (recessive), Curly hair, Widow's peak, Dimpled cheeks, Tongue rolling and folding, Mid digital hair, Hitchhiker's thumb, Clasping of hands, Cleft chin and Attached ear lobe 2. Simple genetic problems based on monohybrid cross, dihybrid cross, trihybrid cross, incomplete dominance, co-dominance and gene interactions. 3. Use of probability in solving problems of genetics. (Sum rule & Multiplication rule) 4. Simulation exercises using beads or seeds to study the gene interactions: 9:3:4; 12:3:1; 9:7; 9:3:3:1 (comb shapes in roosters); 15:1; 13:3. 5. Linkage maps based on data from two-point and three-point test cross. 6. Preparation of buccal epithelial smear and observation of Barr body. 7. Study of polyploidy in onion root tip by colchicine treatment. 8. PTC testing in a population and calculation of allele and genotype frequencies. 9. Study of pedigree charts of Autosomal Dominant trait, Autosomal recessive trait, X-linked Dominant traits, X-linked recessive traits and Y-linked traits). 10. Study of abnormal karyotypes with the help of photographs	

Part C-Learning Resources

1. D.P. Snustad, and M.J. Simmon , Genetics, 7th Ed., John Wiley & Sons. (Singapore) 2015 ISBN: 978-1- 119-14228-7.
2. Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics. X Edition.

3. B.A Pierce. Genetics - A Conceptual Approach,. 4 th Ed., W.H. Freeman & Co. (New York) 2012 ISBN:13: 978-1-4292-7606-1 / ISBN:10:1-4292-7606-1.
4. A.J.F Griffiths, S. R Wessler, S. B Carroll & J. Doebley, An Introduction to Genetic Analysis,. 10th Ed., W.H. Freeman & Company (New York). 2010 ISBN:10: 1- 4292-2943-8 2.
5. Peter. J. Russell. (2009). iGenetics: A molecular approach. 3rd Edition.
6. P.K. Gupta. Elements of Genetics. Rastogi Publications
7. Verma P.S. & Agarwal V.K (2009) Genetics. S. Chand Publications
8. B. D. Singh FUNDAMENTALS OF GENETICS (13th Edition)- Medtech Science Press

Part A - Introduction			
Semester	**I**		
Name of the Course ID2: 250/BIOT/CC102	**Basic CELL BIOLOGY**		

Course Learning Outcomes (CLO):

After completing the course, the learner will be able to:

1. Understand the structures and functions of basic components of plant and animal cell, especially macromolecules, membranes and organelles
2. acquire knowledge about the organizational and functional aspects of cell and cell organelles
3. cultivate knowledge regarding basics of components of cell wall cell membrane and its role in transport.
4. Understand the basic principles of life, how a cell divides and how it is so highly regulated
5. Acquire knowledge regarding cell death and what happens when a cell does not follow the rules of cell cycle.
6. Understand the concept of cell signalling, cell interactions and structures involved in these.

Credits	**Theory**	**Practical**	**Total**
	3	1	4
Contact Hours	3	2	5
Max. Marks:100	**Time: 2h (Theory), 2h (Practical)**		

(50TE+ 25TI + 05 PI + 20PE)	

Part B- Contents of the Course

Instructions for Paper-Setter

Nine questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining eight questions will be set taking two questions from each unit. The candidates will be required to attempt Q.No.1 & four others selecting one question from each unit. All questions carry equal marks.

	CONTACT HOURS
UNIT I a) Historical perspectives. Discovery of cell, the cell theory, ultra structure of a prokaryotic cell & eukaryotic cell- (both plant and animal cells) b) Structure and function of cell wall - Bacterial and Plant. Ultra structure of plasma membrane – fluid mosaic model, membrane fluidity, Transport across membranes - Symport, antiport, uniport, active and passive transport. Transport of macromolecules across plasma membrane. c) Differentiation of cell surface: Basement membrane, tight junction, gap junctions, Desmosomes, hemidesmosomes.	**12**
UNIT II a) Structure & Functions of cell organelles: Endoplasmic Reticulum (SER & RER), golgi apparatus, Lysosomes, b) Microbodies (peroxysomes and glyoxysomes), Ribosomes and its types, centrioles, basal bodies. c) Structure, functions & biogenesis of mitochondria, chloroplast. d) Cytoskeletal structures: microtubules, microfilaments (actin, myosin), Intermediate filament	**12**
UNIT III a. Structure and organization of nucleus: nuclear membrane, organization of chromosomes-structural organization of chromatids, centromere, chromatin, telomere b. Cell division: Cell cycle, mitosis and meiosis, regulations of cell cycle and check points and proteins involved in cell cycle check points.	**11**

UNIT IV **a)** Extracellular Matrix: Composition, molecules that mediate cell adhesion, membrane receptors for extra cellular matrix. **b)** Programmed cell death. Apoptosis **c)** Cancer: Carcinogenesis, agents promoting carcinogenesis, characteristics of cancer cells, Oncogenes, tumour suppressor gene.	**10**

List of Practical:

1. Operation and working principle of simple and compound microscope.
2. To study plant cell by temporary mount.
3. Observation of permanent slides (Prokaryotic, animal & plant cell)
4. Use of Micrometry, measurement of onion epidermal cells and yeast.
5. Vital staining of mitochondria with Janus Green B in buccal epithelium or plant epidermal cells.
6. Study the effect of temperature & organic solvent on semi permeable membrane.
7. Demonstration of Technique of dialysis.
8. Study of plasmolysis and deplasmolysis in cells
9. Study of different mitotic stages in onion root tip cells
10. Study of meiosis in plant flower buds

Part C-Learning Resources

a) Geoffrey M. Cooper, Robert E. Hausman, 2007. The Cell-A molecular approach (Fourth Edition)- ASM Press Washington D.C.

b) Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley & Sons.Inc.

c) Harvey Lodish, Arnold Berk, S. Lawrence Zipursky, Paul Matsudaira, David Baltimore and James Darnell, 2009. Molecular Cell Biology (Fourth Edition). Media Connected – W.H.Freeman and Company.

d) P.S. Verma and V.K. Agarwal, 2012, Concepts of Cell Biology, S.Chand & Company Ltd., New Delhi;

e) Ambrose, and Dorothy, M., Easty 1970. Cell Biology, ELBS Publications

f) Bruce Alberts, Alexander Johnson, Julian Lewis, et al., 2014 Molecular Biology of Cell –Garland publications

g) Gardener, E.J., Simmons M.J. and Snustad D.P. 1991. Principles of Genetics –John Wiley and Son Publications.

Part A - Introduction	
Semester	**I**
Name of the Course ID3 : 250/BIOT/CC103	**BASICS OF BIOMOLECULES**

Course Learning Outcomes (CLO):

1. After successful completion of the programme, students will gain significant knowledge of structural biochemistry and how these small biomolecules attribute in constructing higher living organism.
2. Students will learn the structure and properties of carbohydrates, proteins, lipids, cholesterol, DNA, RNA, complex lipids, and their importance in biological systems
3. Students will acquire an in-dept knowledge of nucleic acid (structural and properties) which will help in understanding the basis molecular processes of living beings.
4. The students will know the distribution, arrangement, and properties of biomolecules in dietary products, which will impart awareness in adapting healthy lifestyle and student can be acquainted in assisting dietician and nutritionist.
5. Students will know how to test the presence of biomolecules in our surrounding and how to differentiate between carbohydrates/ proteins/ lipids and nucleic acid. This will help in assessing the nutrition value of the food consumed.
6. The students will be able to implement the use of instruments like and UV-VIS spectroscopy, centrifugation, and chromatography.

Credits	**Theory**	**Practical**	**Total**
	3	1	4
Contact Hours	3	2	5
Max. Marks: 100 100 (50TE+ 25TI + 05 PI + 20PE)	**Time: 2h (Theory), 2h (Practical)**		

Part B- Contents of the Course

Instructions for Paper-Setter

Nine questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining eight questions will be set taking two questions from each unit. The candidates will be required to attempt Q.No.1 & four others selecting one question from each unit. All questions carry equal marks.

UNIT I Amino acids & Proteins: Structure & Function a) Amino Acid: Structure, specific rotation, electrochemical properties, classification based on R-group, nutritional requirement, and metabolic fate b) Representation of peptide bond; Chemical bonds involved in protein structure c) Protein configuration: Primary structure, Secondary structure (α- helix and β-pleated sheet), Tertiary structure (myoglobin) and Quaternary structure (Hemoglobin) d) Classification of Proteins: Based on shape, composition, biological function. Denaturation and renaturation of proteins	**CONTACT HOURS 12**
UNIT II Carbohydrates: Structure and Function a) Nomenclature and Definition; Classification: Monosaccharides, Oligosaccharides and Polysaccharides b) Monosaccharides: Isomerism; Mutarotation; Structure-Linear form and Ring form, pyranose and furanose structure; anomer; epimers c) Oligosaccharides: reducing and non-reducing sugar; disaccharides (sucrose, lactose, maltose, cellobiose, isomaltose, trehalose); artificial sweeteners d) Polysaccharides: Homopolysaccharides (Starch, Glycogen, Cellulose, Pectin & Chitin), Heteropolysaccharides (Hyaluronic acid & Chondroitin)	**12**
UNIT III Lipids: Structure and functions a) Importance and definition of lipids; basic structural components; Fatty Acid-saturated and unsaturated fatty acids (nomenclature & structure); Biological roles of lipids b) Simple lipids (Fats & Oils); Compound (Phospholipids & Glycolipids) c) Derived Lipids (Steroids: cholesterol – its structure and biological properties; Terpenes; Carotenoids)	**11**
UNIT IV Nucleic acids: Structure and functions a) Introduction; Types of nucleic acids; Structural components of nucleic acids	**10**

b) Nitrogenous bases: Structure of Pyrimidine & Purine derivatives; modified nitrogenous bases; tautomerism in nitrogenous bases; Nucleosides: nomenclature & structure
c) Nucleotides: nomenclature & structure (ribonucleotide & deoxyribonucleotides), functions of nucleotides
d) Double helical model of DNA structure, Chargaff's Rule, Variants of double helical DNA (A, B, C and Z-DNA), denaturation and annealing of DNA.

List of Practicals

1. Preparation of solution with specific concentration and pH.
2. Preparation of stock and working solution.
3. To perform qualitative tests to find the presence of carbohydrates in a sample.
4. To perform tests to differentiate between monosaccharide, disaccharide, and polysaccharide.
5. To perform tests to identify reducing and non-reducing sugars.
6. To perform qualitative tests to find the presence of proteins in a sample
   a) Biuret test
   b) Ninhydrin test
   c) Lowry's test
7. To perform paper chromatography test to separate mixture of amino acids.
8. To perform qualitative & quantitative determination of nucleic acids.
9. To perform tests to find the presence of lipids in a sample.

Part C-Learning Resources

1. Fundamentals of Biochemistry by J.L. Jain (S. Chand & Company Ltd.)
2. The Foundations of Biochemistry by Lehninger
3. Biochemistry – J. M. Berg, J. L. Tymockzo, L. Stryer, 5th ed
4. Biochemistry-Reginald H. Garret, Charles M. Grisham 6th ed
5. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.H Freeman and Co.
6. Essentials Of Biochemistry, U. Satyanarayana, U. Chakrapani, (2021), Publisher- Elsevier

SEMESTER-II

INTERDISCIPLINARY - BIOTECHNOLOGY

Part A - Introduction			
Semester	**II**		
Name of the Course ID4: 250/BIOT/CC201	**GENERAL MICROBIOLOGY**		
Course Learning Outcomes (CLO): After completing this course, the learner will be able to: • Learn the historical developments in the field of Microbiology. • Understand the criteria used for classification of bacteria and their diversity • Understand the modes of nutrition in bacteria and the methods to cultivate them. • Develop the basic knowledge of microbial growth and reproduction. • Apply the concepts of control of microorganisms by physical methods and by chemicals or chemotherapeutic agents. • Learn the environmental and ecological niche of microorganisms and their impact in environment. • Analyse the effect of microbial water pollution and learn the waste water treatment processes. • Develop knowledge about the role of micro-organisms in food and their impact on humans via food.			
Credits	**Theory**	**Practical**	**Total**
	3	1	4
Contact Hours	3	2	5
Max. Marks: 100 (50TE+ 25TI + 05 PI + 20PE)	**Time: 2h (Theory), 2h (Practical)**		

Part B- Contents of the Course
Instructions for Paper-Setter

Nine questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining eight questions will be set taking two questions from each unit. The candidates will be required to attempt Q.No.1 & four others selecting one question from each unit. All questions carry equal marks.

UNIT I **Fundamentals of microbiology:** History and Evolution of Microbiology with special reference to the major scientific contributions. **Microbial Classification & Diversity:** Microbial taxonomy, criteria used for classifying bacteria including molecular approaches, current classification of bacteria. **Microbial Diversity:** Difference between prokaryotic and eukaryotic microorganisms. General characteristics of different groups: Acellular microorganisms (Viruses, Viroids, Prions) and Cellular microorganisms (Bacteria, Archaea, Algae, Fungi and Protozoa) with emphasis on distribution, occurrence and morphology.	**CONTACT HOURS** **10**
UNIT II **Ultrastructure of Bacteria:** Cell envelope - capsule and slime layer, Cell-wall: Composition and detailed structure of Gram positive and Gram negative cell walls, mechanism of Gram's staining. Cell Membrane: Structure, function and chemical composition of bacterial and archaeal cell membranes. Cellular appendages - pili, flagella and fimbriae, inclusion bodies, Plasmid DNA and chromosomal DNA, Endospores and sporulation in bacteria. **Viruses:** General characteristics of viruses, structure, different shapes and symmetries with one example of each type, classification of viruses on the basis of nucleic acids with one example of each. Brief idea of lytic and lysogenic cycle. **Microbial Cultivation and preservation:** Nutritional categories of micro-organisms. Culture media and its types, methods of Isolation/Purification. Preservation and maintenance of pure cultures.	**12**
UNIT III **Bacterial Genetics**: Conjugation, transduction (generalized and specialized), and transformation. **Microbial Growth:** Growth curve, Generation time, synchronous, batch and continuous culture, measurement of growth and factors affecting growth of bacteria. **Control of Microorganisms by Physical Agents**: moist heat sterilization- Boiling, Pasteurization, Fractional sterilization and autoclave. Dry heat sterilization – Incineration and hot air oven.	**12**

Gupta

Filtration–Diatomaceous earth filter, Seitz filter, membrane filter and HEPA; Radiation: Ionizing radiation – γ-rays and non-ionizing radiation – UV rays	
UNIT IV **Control of Microorganisms by Chemical methods:** Alcohols, aldehydes, phenols, halogen, metallic salts, Quaternary ammonium compounds and sterilizing gases as antimicrobial agents. **Control of Microorganisms by Chemotherapeutic agents:** Source, utility and mode of action of major chemotherapeutic agents. **Microbial ecology**: Physical environments: microenvironment and niche. Interactions of microorganisms with living and non-living. Nutrient cycling interactions. **Water Microbiology:** Bacterial pollutants of water, coliforms and non- coliforms. Sewage composition and its disposal.	**11**

List of Practical:

1. Rules to follow in Microbiology laboratory & To study the principle and applications of important instruments (Laminar air flow unit, autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter) used in the microbiology and biotechnology laboratory.
2. Staining method – simple staining, gram staining and negative staining
3. Staining of *Aspergillus niger* by lactophenol cotton blue. [*A. niger* from rotten citrus fruit]
4. Bacterial cell motility – hanging drop technique.
5. Determination of cell size by micrometry.
6. Preparation of cotton plugs for sterilization of media.
7. Preparation of culture media for bacteria, fungi and their cultivation.
8. Plating techniques: Spread plate, pour plate and streak plate.
9. Isolation of bacteria from soil, water and air.

Part C-Learning Resources Suggested readings:

1. Jay JM, Loessner MJ and Golden DA (2005). Modern Food Microbiology.7th edition, CBS Publishers and Distributors, Delhi, India.
2. Willey, J., Sherwood, L. and Woolverton, C. J. (2017) Prescott's microbiology, McGraw-HillEducation.
3. Madigan MT, Martinko JM and Parker J. (2009). Brock Biology of Microorganisms.12th edition.Pearson/Benjamin Cummings.
4. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology.5th edition, McGraw Hill Book Company.

5. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan.
6. Tortora, G. J., Funke, B. R. and Case, C. L. (2016) Microbiology: An introduction, Pearson Education.

Part A - Introduction			
Semester	**II**		
Name of the Course ID5: 250/BIOT/CC 202	**CELLULAR METABOLISM**		
Course Learning Outcomes (CLO): 1. Students will appreciate how the collection of thousands inanimate molecules that constitute living organisms interact to maintain and perpetuate life governed solely by the physical and chemical laws as applicable to the non-living thing. 2. Students will basics of metabolism inculcating inside human body. 3. Students will have knowledge how these small biomolecules attribute in constructing higher living organism. 4. This will broaden their understanding of how biochemical changes relate to physiological alteration in the body. The study of biochemistry will provide thoughtful vision how abnormal functioning of these biomolecules can lead to adverse pathological conditions. 5. Students will learn basic metabolic pathways that leads to energy generation, carbohydrates assimilation, oxidation of fatty acids etc. Abnormality in the functioning of these metabolic pathways is directly related with adverse medical conditions. 6. Students will gain knowledge of several regulatory pathways that affects metabolic pathways.			
Credits	**Theory**	**Practical**	**Total**
	3	1	4
Contact Hours	3	2	5
Max. Marks: 100 **(50TE+ 25TI + 05 PI + 20PE)**	**Time: 2h (Theory), 2h (Practical)**		

Part B- Contents of the Course

Instructions for Paper-Setter

Nine questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining eight questions will be set taking two questions from each unit. The candidates will be required to attempt Q.No.1 & four others selecting one question from each unit. All questions carry equal marks.

	CONTACT HOURS
UNIT I Metabolism Overview and Bioenergetics a) Metabolism overview & its terminology; metabolic pathways; catabolism versus anabolism, Central Pathways, Anaplerotic Pathways, Secondary pathways b) Key chemical reactions in metabolism (oxidation-reduction; ligation; isomerization; group-transfer; hydrolytic & addition-removal of functional groups) c) ATP as Universal Currency of Free Energy in Biological Systems d) Regulation of Metabolic Pathways	**10**
UNIT II Carbohydrate Metabolism a) Glycolysis (phases, enzymes involved and energetics); Fate of pyruvate under aerobic and anaerobic conditions: Muscle glycolysis and alcoholic fermentation. Oxidative Decarboxylation of Pyruvate to Acetyl-CoA b) Citric acid cycle or Krebs cycle (overview, enzymes involved, reaction steps, & its energetics); Amphibolic roles of the citric acid cycle; Modification of TCA cycle: Glyoxylate Cycle; c) Pentose phosphate pathway and its significance. Gluconeogenesis, Glycogenolysis and Glycogenesis.	**12**
UNIT III Lipid & Protein Oxidation a) Overview of fatty acids: General considerations, activation of fatty acids, reactions of fatty acid oxidation b) Oxidation of Even-chain Saturated Fatty Acids (Knoop's β Oxidation Pathway); Oxidation of Unsaturated Fatty Acids.	**12**

c) Basics of Fatty Acids biosynthesis: Acetyl-CoA transport into the cytosol, Production of malonyl-CoA, Intermediates in fatty acid synthesis and the ACP, The fatty acid synthase complex. d) Ketogenesis: General considerations, Biosynthesis, and utilization of ketone bodies, Ketogenic and antiketogenic substances; metabolic water	
UNIT IV Electron Transport & Oxidative Phosphorylation a) Electron flow as source of ATP energy; Site of oxidative phosphorylation; ATP synthetase b) Electron-transport complexes (respiratory chain); Proton motive force; Chemi-osmotic model c) Oxidation of extra-mitochondrial NADH (Malate-oxaloacetate-aspartate shuttle & Glycerophosphate-dihydroxyacetone phosphate shuttle) d) Respiratory Inhibitors: Inhibitors of electron transport; Inhibitors of oxidative phosphorylation; Uncouplers of oxidative phosphorylation; Ionophores of oxidative phosphorylation	**11**

List of Practicals

1. Preparation of buffers at a specific molarity and pH
2. To demonstrate the formation of standard curve and its role in calculating concentration of un-known sample.
3. To estimate total protein in liver homogenate.
4. To estimate the blood glucose level.
5. To estimate serum creatinine level.
6. To demonstrate fate of pyruvate under anaerobic conditions (alcoholic fermentation).
7. To demonstrate endergonic and exergonic reactions.
8. To construct energy yield in terms of ATP of aerobic oxidation of 2 moles of Glucose.
9. To construct stochiometric balance sheet and energy yield in terms of ATP of C18 fatty acid oxidation.
10. To learn about urine urea nitrogen test, its purpose, and result analysis.

Part C-Learning Resources

1. Fundamentals of Biochemistry by J.L. Jain (S. Chand & Company Ltd.)
2. The Foundations of Biochemistry by Lehninger

3. Biochemistry – J. M. Berg, J. L. Tymockzo, L. Stryer, 5th ed
4. Biochemistry-Reginald H. Garret, Charles M. Grisham 6th ed
5. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.H Freeman and Co.
6. Essentials Of Biochemistry, U. Satyanarayana, U. Chakrapani, (2021), Publisher- Elsevier

Part A - Introduction			
Semester	**II (CORE)**		
Name of the Course ID6: 250/BIOT/CC203	**Basics in MOLECULAR BIOLOGY**		
Course Learning Outcomes (CLO): After completing the course, the learner will be able to : 1. Gain Knowledge about DNA as genetic material and various experiments leading to this discovery. 2. Understand process of replication in both prokaryotic and eukaryotic systems, various enzymes involved in the process and inhibitors of the replication 3. Gain Knowledge of mutations and its various types. They will get in depth knowledge regarding multiple repair systems present cellular level. 4. Get an insight into process of transcription in both prokaryotic and eukaryotic system, post transcriptional changes all the types of RNA. 5. Understand the Process involved in translation, various proteins required for the process, post translational modifications. 6. Acquire knowledge about regulation of gene expression.			
Credits	**Theory**	**Practical**	**Total**
	3	1	4
Contact Hours	3	2	5
Max. Marks: 100 **(50TE+ 25TI + 05 PI + 20PE)**	**Time: 2h (Theory), 2h (Practical)**		

Part B- Contents of the Course

Instructions for Paper-Setter

Nine questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining eight questions will be set taking two questions from each unit. The candidates will be required to attempt Q.No.1 & four others selecting one question from each unit. All questions carry equal marks.

	CONTACT HOURS
UNIT I a. Introduction to Molecular Biology, Types of genetic materials- Experiments of Griffith, Avery, MacLeod and McCarty; Hershey and chase; John Cairns experiment; Meselson-Stahl experiment, Central dogma of life. b. Replication of DNA, Models of DNA replication, Mechanism of DNA replication in prokaryotes (initiation, elongation, replication fork, replication machinery, termination) c. Enzymes and proteins involved in DNA replication (Nucleases, DNA polymerases, DNA helicases, Gyrases, SSBP, Topoisomerase, Primase). d. Inhibitors of replication	12
UNIT II a) Mutagens: Defination & types ; Physical mutagen- radiation, Chemical mutagens-alkylating agent, nitrous acid, hydroxylamine; Ames test b) DNA Damage & its types, Gene Mutation and its types (Substitution, Indel, Gene amplification) c) DNA repair- Photoreactivation, Base excision repair, Nucleotide excision repair, Mismatch repair, Translesion synthesis, Recombinational repair, Non-homologous end joining	12
UNIT III a) Mechanism of transcription in prokaryotes and eukaryotes. Enzymes and proteins involved in transcription, b) RNA splicing and processing: processing of pre-mRNA: 5' cap formation, polyadenylation, splicing, rRNA and tRNA splicing. c) Inhibitors of transcription.	11
UNIT IV d) Genetic code - characteristics and properties, Wobble hypothesis.	10

e) Protein biosynthesis in prokaryotes and eukaryotes, post translational modifications, protein degradation. Inhibitors of protein synthesis. f) Regulation of gene expression (*lac* & *trp* operons)	

List of Practical:

1. Isolation of genomic DNA from bacterial cells.
2. Isolation of total RNA from mammalian cells.
3. Estimation of DNA by diphenylamine reaction.
4. Estimation of RNA by orcinol method
5. Quantitative Estimation of DNA and RNA by UV Spectrophotometry
6. Estimate purity of DNA sample by calculating DNA/protein ratio.

Part C-Learning Resources

a) David L. Nelson & Michael M. Cox. (2017) Lehninger principles of biochemistry (7th Edition) W H Freeman & Co.
b) Lodish. H. Berk. A. Lawrence. A. Matsudaira. A. Baltimore. D and Dernell. J. Molecular Cell Biology (Fourth Edition). – W.H.Freeman and Company. 2009
c) Cooper G M & Hausman E. The Cell - A Molecular Approach. (6th edition). Sinauer Associates 2013
d) P.S. Verma and V.K. Agarwal. 2012. Concepts of Cell Biology. S.Chand & Company Ltd., New Delhi. 2012
e) Lewin. B . GENES X. (10th edition). Jones & Bartlett Learning. 2011

SEMESTER-III

INTERDISCIPLINARY - BIOTECHNOLOGY

Part A - Introduction	
Semester	**III**
Name of the Course ID7: 250/BIOT/CC301	**BioAnalytical Tools**
Course Learning Outcomes (CLO):	

1. After completing this course, the learner will be able to acquire knowledge of analytical tools and techniques of biotechnology understanding of good laboratory practices.
2. The course will provide in depth knowledge of basic instruments involved in biological laboratory, so that the students can easily be acquainted as operators in several diagnostic laboratory.
3. Practical will provide Handling of general & specific problems while processing of experimental material and learn to devise solution by choosing appropriate methodology/techniques for processing of bio materials/products.
4. Students will exhibit the knowledge of testing of DNA/Proteins/Fingerprints/antibodies in the field of research of Biotechnology/Molecular Biology
5. Students will understand the biochemical techniques essential for working in a biotechnological laboratory.

Credits	Theory	Practical	Total
	3	1	4
Contact Hours	3	2	5
Max. Marks: 100 **100 (50TE+ 25TI + 05 PI + 20PE)**	**Time: 2h (Theory), 2h (Practical)**		

Part B- Contents of the Course

Instructions for Paper-Setter

Nine questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining eight questions will be set taking two questions from each unit. The candidates will be required to attempt Q.No.1 & four others selecting one question from each unit. All questions carry equal marks.

	CONTACT HOURS
UNIT I **Microscopy:** a)Terms-Magnification, Numerical aperture, Resolving power, Refractive index b)Concept and working of Simple microscope c)Compound Microscope: Dark field microscope, phase contrast microscope, florescence	**10**

microscope d)Electron microscopy (TEM and SEM)	
UNIT II **Principle, laws and Applications of:** **a)** Colorimeter, Fluorimeter, Centrifuge, Sectrophotometer b)Cell fractionation techniques: Isolation of sub-cellular organelles and particles, c)Differential centrifugation and , Density gradient centrifugation	**11**
UNIT III **Introduction to the principle of chromatography:** a)Paper chromatography, thin layer chromatography b) Column chromatography: Silica Gel filtration, Affinity, Ion exchange chromatography, c)Gas chromatography, HPLC	**12**
UNIT IV **Molecular Biology Techniques:** **a)**Introduction to Electrophoresis: polyacrylamide gel (native and SDS-PAGE) electrophoresis, Agrose-gel Electrophoresis b) Immunoelectrophoresis, Isoelectric focusing, Western blotting, Southern and Northern Blotting, ELISA, DOT Blot Technique, Colony Hybridization, Microarray c)Introduction of Biosensors, types and application d) Nanotechnology and application	**12**
List of Practicals 1. Preparation of solution with specific concentration and pH. 2.To perform Agarose gel elecrophoresis and determination of molecular weight of DNA sample 3.To perform SDS Polyacrylamide Gel Electrophoresis of proteins 4. Separation of amino acids in given samples by paper chromatography 5.To identify sugars in given sample by TLC 6.To perform Column Chromatography(Gel filtration/Affinity Chromatography) 7.To study Beer's Lambert Law by Spectrophotometer 8.Demonstration of Biosensors by working model 9. Preparation of nanoparticles in a given sample	

10. Preparation of Sub Cellular Fractions from rat liver cell
Part C-Learning Resources 1Lehninger Principles of Biochemistry by David L Nelson 2 Introductory Practical by S.K. Sahani and Randhir Singh 3 Practical Manual of Biotechnology by Raju Mahajan 4 Fundamentals of Techniques of Biophysics and Molecular Biology by Pranav Kumar 5 Principles and Techniques in Biochemistry and Molecular Biology by Wilson and Walker

Part A - Introduction	
Semester	**III**
Name of the Course ID8 : 250/BIOT/CC302	**FUNDAMENTALS OF IMMUNOLOGY**

Course Learning Outcomes (CLO):

On successful completion of the course the students will gain and be able to demonstrate following knowledge:

1. Understand the concepts of **immunology,** get an insight about the different kind of defence mechanism our body possesses for protection from various infections and diseases.

2. Learners will gain knowledge about how our immune system actually work and our body defence mechanism help us to fight against various infections and diseases.

2. Learners will get an insight of scope and applications of immunology in pharma and research sector. The students will be able to demonstrate the knowledge of applications of immunology for human welfare.

3. Gain knowledge about the clinical immunology where they will learn about the different tests or methods to diagnose the different immune disorders, infections and diseases. Learners will also get an insight of treatment of immune disorders, various infections and diseases.

4. Gain knowledge of structure, working, maintenance/calibration and safety measures during handling of clinical lab instruments and chemicals. Also get insight of maintenance of aseptic conditions and proper disposal of biochemicals.

5. Gain knowledge about Vaccines and Recent Advances in development of vaccines.

Credits	Theory	Practical	Total
	3	1	4
Contact Hours	3	2	5
Max. Marks: 100 (50TE+25TI++05PI+20PE)	**Time: 2h (Theory), 2h (Practical)**		

Part B- Contents of the Course

Instructions for Paper-Setter

Nine questions will be set in all. Question No.1 comprising objective/short answer type questions from the entire syllabus, will be compulsory. The remaining eight questions will be set taking three questions from each section. The candidates will be required to attempt Q.No.1 & four others selecting one questions from each section. All questions carry equal marks.

UNIT I	CONTACT HOURS
• **Immunology:** Introduction, History and Scope. Terminology of immune system • **Immunity:** Definition, types of Immunity: Innate, Adaptive/acquired (active, passive, natural/artificial, Humoral and Cell mediated immunity). Features of Immune Response – memory, cell specificity/diversity, recognition of self and nonself, clonal nature of immune response.	**12**

• **Cells and Organs of the Immune System:** Hematopoiesis, immune cells (Granulocytes, lymphocytes, monocytes/macrophages, dendritic cells, NK cells). Primary (bone marrow, thymus) and secondary lymphoid organs (spleen, lymph nodes, MALT). • **Antigens:** Immunogenicity and antigenicity, Origin, Properties, types, haptens, epitopes, adjuvants. Factors affecting antigenicity. • **Immunoglobulins (Antibodies):** Fine Structure and classes of Ab, Ab mediated functions. Antigenic determinants of Ab- Isotypes, Allotypes, ideotypes.	
UNIT II • **Organisation & Expression of immunoglobulin genes:** Genetic modal for Ig structure, Organisation of Ig genes, Gene rearrangements in heavy chain, mechanism of gene rearrangements, Productive and non-productive gene recombination, Allelic exclusion, Generation of antibody diversity, Class switching & expression of Ig genes, Regulation of Ig gene transcription. • **Antigen-antibody interactions:** Binding sites, concept of avidity, affinity, Cross reactivity, Precipitation- Single & double diffusion reactions in gels, Immunoelectrophoresis, Agglutination & Heamagglutination, Agglutination inhibition, RIA, ELISA and its types, Immunofluorescence. • **Complement system:** Classical pathway, Alternate pathway & Lectin pathway, Functions of complement.	**12**
UNIT III • **Innate Immunity:** 1st, 2nd and 3rd line of defence mechanisms, Inflammation, Mechanism of innate immune recognition (PRRs). • **Antigen Processing and Presentation:** Major Histocompatibility Complex (MHC): Types, structure, function, and role in antigen processing and presentation. • **Humoral Immune Response:** Primary and Secondary immune response – B cells in antibody formation (differentiation, maturation and activation of B cells), T-dependent and T-independent antigens, Affinity Maturation, Class Switching • **Cell -mediated Immune Response:** T-Cell Receptors: Structure and Roles, T-Cell Receptor Complex, T-Cell Maturation, Activation, and Differentiation, proliferation of	**11**

clonally selected T cells and their effector functions, concepts of T-helper 1 (TH1) and T helper 2 (TH2) cell.	
UNIT IV • **Hypersensitivity Reactions:** Types (I–IV), brief description and clinical relevance. • **Introduction, history and different types and generations of vaccine:** Principles of vaccination, passive & active immunization, I generation or traditional vaccine (live attenuated and inactive killed vaccine), II generation (toxoid, subunit and conjugate vaccine), III generation (recombinant, DNA, mRNA, viral vector), IV generation or next generation vaccine (synthetic peptide and Nano vaccine, Autologous and personalised vaccine) herd immunity • **Immunotherapy:** Basic concept of Immunotherapy including monoclonal antibodies.	**10**

List of Practical:

1. Agglutination test: Blood grouping by agglutination, pregnancy test.
2. ELISA (Enzyme-Linked Immunosorbent Assay): Detection of specific antibodies or antigen.
3. Hemoglobin Count.
4. RBC Count.
5. Total leukocyte count (TLC).
6. Differential leukocyte count (DLC).
7. Immunodiagnostic tests for diseases (e.g.,Widal).
8. Ouchterlony double diffusion (ODD) technique.

Part C-Learning Resources

1. Kuby Immunology: Sharon Stranford, Judith A Owen, Jenni punt, Patricia Jones.
2. Biotechnology: extending horizon- B. D. Singh
3. IBT: Introduction to Biotechnology: Anmolka Jaini
4. Immunology and Microbiology: N. Arumugam, L.M. Narayanan, Dulsy Fatima.
5. Biotechnology practical handbook: Anmolka Jaini
6. Text book of Immunology: Arvind Kumar

Part A - Introduction	
Semester	**III Core Course**
Name of the Course ID9: 250/BIOT/CC303	**BASIC ENZYMOLOGY**

Course Learning Outcomes (CLO):

- The students will be able to assign systemic name to enzymes and from the E.C. number they can explain the reaction it catalyses.
- The students will able to understand the concept of importance of kinetics of enzyme, its inhibitions and how they influence normal physiology and drug action
- The students have a deeper insight in to the fundamentals of enzyme structure, function, and chemical nature of enzymes. Discussion on current applications and future potential of enzymes.

	Theory	Practical	Total
Credits	2	1	3
Contact Hours	2	2	4
Max. Marks:75 (35TE+ 15TI + 5PI + 20PE)	**Time: 2h (Theory), 2h (Practical)**		

Part B- Contents of the Course

Instructions for Paper-Setter

Total five questions will be set. Question 1 comprising objective/ short answer type will be compulsory and of 9 marks. The remaining six questions will be set taking two questions from each unit. Students

must attempt total four questions including Q1 (compulsory) and three questions taking one from each unit. Q1 will be of 8 marks and remaining questions of 9 marks.

	CONTACT HOURS
UNIT-I Nomenclature and Classification	
a) Historical resume: Nomenclature and classification; major features of I.U.B classification system; knowledge of various terms such as holoenzyme, apoenzyme, co-enzyme, prosthetic group, co-factors, ribozymes, abzymes, metalloenzymes, monomeric & oligomeric enzymes, Isoenzymes, or Isozymes; Biological Roles of Enzymes (Endo- and exo-enzyme) b) Chemical Nature of Enzymes; Characteristics of Enzymes (colloidal nature, catalytic nature, turn-over number, Specificity of enzyme action, thermolability- denaturation and renaturation) c) Understanding of Energy Mechanics of Enzymatic Reactions (standard free energy, ground & transition state, activation energy, energy diagram of reaction, rate limiting step, feed-back inhibition, zymogen)	10
UNIT-II Mechanism of Enzyme Action	
a) Michaelis Menten Hypothesis; Derivation Michaelis-Menten equation; Michaelis constant, Significance of K_m and V_m values) b) Active Site & its detailed features; Fischer's lock and key model; Koshland's induced fit model c) Reversible enzyme inhibition (Competitive inhibition, Non-competitive inhibition, and Uncompetitive inhibition)	10
UNIT-III Coenzymes, Enzymes and their Applications	
a) Co-enzymes: Mechanism of action of important coenzymes NAD, FAD, FMN, TPP, Pyridoxal sulphate, lipoic acid, CoASH and vitamin B12 b) Methods of enzyme immobilization and applications of immobilized enzymes.	10

c) Applications of enzymes in food, sugar, dairy, detergent, leather industry, medicine & diagnostics.	

List of Practicals

1. Demonstration of Starch Digestion by Salivary Amylase at optimum conditions.
2. To demonstrate effect of pH on enzyme activity.
3. To demonstrate effect of temperature on enzyme activity.
4. To demonstrate the effect of inhibitors on the action of enzyme.
5. To study the activity of trypsin in cell culture.
6. Assay of Enzyme Activity and Specific Activity e.g. Acid Phosphatase.
7. Partial Purification of Acid Phosphatase from Germinating (Mung) Beans by Ammonium Sulphate Fractionation.

Part C-Learning Resources

1. Fundamentals of Biochemistry by J.L. Jain (S. Chand & Company Ltd.)
2. The Foundations of Biochemistry by Lehninger
3. Understanding enzymes: Palmer T., Ellis Harwood ltd.,2nd ed
4. Enzyme structure and mechanism. Alan Fersht, Freeman & Co 2nd ed
5. Enzyme kinetics Siegel Inter-science – Wiley
6. **https://egyankosh.ac.in/bitstream/123456789/71261/1/BBCCL-108.pdf**

SEMESTER-IV

INTERDISCIPLINARY - BIOTECHNOLOGY

Part A - Introduction	
Semester	**IV**

Name of the CourseID10: 250/BIOT/CC401	Basics of Recombinant DNA Technology		
Course Learning Outcomes (CLO): After completing this course, the learner will be able to: 1. To illustrate creative use of modern tools and techniques for manipulation and analysis of genomic sequences. 2. To expose students to application of recombinant DNA technology in biotechnological research. 3. To train students in strategizing research methodologies employing genetic engineering techniques.			
Credits	**Theory**	**Practical**	**Total**
	3	1	4
Contact Hours	3	2	5
Max. Marks:100 **(50TE+25TI+05PI+20PE)**	**Time: 2h (Theory), 2h (Practical)**		

Part B- Contents of the Course

Instructions for Paper-Setter

Nine questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining eight questions will be set taking two questions from each unit. The candidates will be required to attempt Q.No.1 & four others selecting one question from each unit. All questions carry equal marks.

UNIT I	**CONTACT HOURS**
Recombinant DNA Technology and Genetic Engineering: Introduction, history, scope and applications. **Tools of Recombinant DNA technology:** Steps in gene cloning. Gene cloning tools – Restriction and methylation system in prokaryotes & its application, DNA Ligases, DNA polymerases, alkaline phosphatases and reverse transcriptases. **Gene Cloning Vectors**: Introduction, nomenclature of vectors, properties of a suitable vector. Plasmid vectors (pBR322, pUC18), bacteriophage vectors (lambda, M13), cosmids, phagemids and phasmids. Yeast vectors, Shuttle vectors YAC and BACs. Overview of Expression vectors.	12

UNIT II **In vitro construction of r-DNA molecules:** Isolation of gene of interest and vector DNA and their ligation, cohesive and blunt ends, modification of cut ends, linkers and adaptors. Integration of DNA inserts into the vectors. **Gene Transfer Techniques:** Microinjection, Electroporation, Shot Gun method, Ultrasonication, Lipofection. $CaCl_2$ mediated transformation, competent cells.	12
UNIT III **Selection & Screening of cloned genes**: Screening of transformants and their characterization. Selection of clone having the specific DNA insert - immunological screening, colony hybridization, and nucleic acid hybridisation methods. Marker genes- selectable markers. **Gene Libraries:** Construction of Genomic and cDNA library, advantages and limitations, screening of gene libraries.	10
UNIT IV **DNA amplification through PCR**: Basic features and applications of PCR, RT-PCR. **Changing genes:** Site-directed mutagenesis: Random mutagenesis, Cassette mutagenesis, PCR based site directed mutagenesis.	11
List of Practical: 1. Genomic DNA isolation from plants and animals. 2. Plasmid DNA isolation from *E.coli*. 3. Spectrophotometer analysis of DNA 4. Agarose gel electrophoresis of DNA 5. Restriction digestion of DNA 6. Ligation of DNA fragments. 7. Preparation of competent cells. 8. Transformation of competent cells. 9. Replica plating and Blue white selection.	

10. Amplification of DNA by PCR using random primers

Part C-Learning Resources:

1. S. B. Primrose, R. Twyman. Principles of Gene Manipulation and Genomics (Wiley-Blackwell, ed. 7, 2006).
2. M. Wink. An Introduction to Molecular Biotechnology: Molecular Fundamentals, Methods and Applications in Modern Biotechnology (Wiley, ed. 2, 2011).
3. B. R. Glick., et al. Molecular Biotechnology: Principles & Applications of Recombinant DNA (ASM Press, ed. 4, 2009).
4. DNA cloning: A Practical Approach. Glover and Hames (2001) Oxford University Press.
5. Genetic Engineering. Ahluwalia, K. B. (2002) New Age International (P) Ltd.
6. Brown, T. A. (2006). Gene cloning and DNA analysis (5th ed.). Oxford, UK.: Blackwell Publishing.
7. Clark, D. P. & Pazdernik, N. J. (2009). Biotechnology- applying the genetic revolution. USA: Elsevier Academic Press.

Part A - Introduction			
Semester	**IV**		
Name of the Course ID11: 250/BIOT/CC402	**Introduction to MEDICAL MICROBIOLOGY**		
Course Learning Outcomes (CLO): On completion of the course students are able to : 1.Learn about historical development of Medical microbiology 2 will understand the mechanisms of infectious diseases caused by bacteria, virus, fungus and protozoa 3.Learn about Normal microflora of human body, nosocomial infections, biosafety			
Credits	**Theory**	**Practical**	**Total**
	3	1	4
Contact Hours	3	2	5
Max. Marks: 100 100 (50TE+ 25TI + 05 PI + 20PE)	**Time: 2h (Theory), 2h (Practical)**		

Part B- Contents of the Course

Instructions for Paper-Setter

Nine questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining eight questions will be set taking two questions from each unit. The candidates will be required to attempt Q.No.1 & four others selecting one question from each unit. All questions carry equal marks.

	CONTACT HOURS
UNIT I **Introduction to medical microbiological terminologies** • **Types of infections:** Primary, secondary, cross, endogenous, exogenous, congenial, teratogenic, iatrogenic, laboratory and latent infections • **Carriers and transmission of diseases**: Types & Methods of transmission. • **Definitions of:** MID, ID50, MLD, LD50, Bacteraemia, Septicaemia, contagious, Endemic, epidemic, pandemic, sporadic and prosodemic diseases, Communicable and non-communicable diseases, Epizootic, Enzootic • Normal micro flora of human body • Nosocomial Infections **Morphology, virulence factors, pathogenesis, symptoms, laboratory diagnosis & preventive measures of** • **Gram-Positive Cocci:** *Staphylococcus aureus, Streptococcus pyogenes.* • **Gram-Negative Cocci:** *Neisseria (N. gonorrhoeae, N. meningitidis)*	**10**
UNIT II **Morphology, virulence factors, pathogenesis, symptoms, laboratory diagnosis & preventive measures of** • **Gram-Positive Bacilli:** *Bacillus anthracis, Clostridium botulinum, C. tetani, Corynebacterium diphtheria.* • **Gram-Negative Bacilli:** *Escherichia coli, Klebsiella pneumoniae, Salmonella typhi, Shigella dysentrae, Pseudomonas aerogenosa, Vibrio cholera.* • **Rickettsia and chlamydia:** Brief account	**12**

UNIT III **Morphology, virulence factors, pathogenesis, symptoms & preventive measures of** • **Acid-Fast Bacteria:** *Mycobacterium tuberculosis, Mycobacterium leprae.* • **Spirochetes:** *Treponema pallidum* (Syphilis) • **Protozoan Infections:** *Entamoeba histolytica, Taenia solium, Ancylostoma deudenale, Giardia lamblia, Leishmania donovani, Trypanosoma brucei, Plasmodium.* **Medical Mycology:** Superficial Mycoses (Tinea), Subcutaneous & Systemic Mycoses (*Aspergillus, Candida).*	**12**
UNIT IV **Morphology, pathogenesis, symptoms & preventive measures of** • **Major viral disease** - Chicken pox, Influenza, measles, Mumps, Rubella, Rabies, Hepatitis A,B &C, AIDS, Polio. • **Emerging & Re-Emerging Viruses** (Ebola, Zika, SARS-CoV-2)	**11**
List of Practical: 1. To study antibiotic sensitivity of microbes by Kirby Bauer's method/ development of an antibiogram 2. Identification of given samples by biochemical characterization using IMViC, TSI and Nitrate test. 3. Enzymatic and biochemical tests for Bacteria-Catalase Test, Oxidase Test, Urease Test, Coagulase Test, Bile solubility test 4. Identification and characterization of Normal microflora of nose/ mouth/ skin. 5. Demonstration of Serological test- ELISA. 6. Study of various stages of Malarial parasite in RBCs using permanent mounts/Photomicrographs. 7. Demonstration of cultivation of viruses in embryonated chicken eggs.	

Part C-Learning Resources Suggested readings:

1. Salle A.J. Fundamental Principles of Bacteriology. Tata McGraw-Hill Education
2.Willey, J., Sherwood, L. and Woolverton, C. J. (2017) Prescott's microbiology, McGraw-HillEducation.
3. Kanungo R. (Editor) Ananthanarayan and Paniker's Textbook of Microbiology. University Press.
4. Pelczar MJ, Chan ECS and Krieg NR.(1993). Microbiology.5th edition. McGraw Hill Book Company.
5. Tortora, G. J., Funke, B. R. and Case, C. L. (2016) Microbiology: An introduction, Pearson Education.
6. Subhash Chandra Parija, A Textbook of Microbiology & Immunology, (2023) (Elsevier)
7. Dubey and Maheshwari, A textbook of Microbiology, S Chand Publication

Semester	**IV**		
Name of the CourseID12: 250/BIOT/CC403	**Introduction to Animal Biotechnology**		
Course Learning Outcomes (CLO): a) Students will gain a comprehensive understanding of the principles and applications of biotechnology in the context of animal science. b) Students will be familiar with the methods and applications of animal cell culture, including stem cell technology. c) They will understand and be able to apply techniques like in vitro fertilization, embryo transfer, and other reproductive manipulation methodologies. d) Students will understand the ethical considerations and implications of using biotechnology in animal production and research.			
Credits	**Theory**	**Practical**	**Total**
	3	1	4
Contact Hours	3	2	5
Max. Marks: 100 **(50TE+ 25TI + 05 PI + 20PE)**	**Time: 2h (Theory), 2h (Practical)**		

Part B- Contents of the Course

Instructions for Paper-Setter

Nine questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining eight questions will be set taking two questions from each unit. The candidates will be required to attempt Q.No.1 & four others selecting one question from each unit. All questions carry equal marks.

	CONTACT HOURS
UNIT I Animal Cell Culture a) Introduction, history, and scope of Animal cell culture, primary cell culture & established cell lines, monolayer cell culture & suspension culture, types of substrates used for animal cell culture b) Culture Media for Animal Cells and Tissue – Natural & Synthetic (serum containing media, serum free media, chemically defined media) c) Basic techniques of mammalian cell culture preparation: disaggregation of animal tissues (mechanical, enzymatic and EDTA)	10
UNIT II Animal propagation a) Artificial insemination (AI)- introduction, evaluation of semen, dilution and preservation of semen, procedure of insemination, advantages of AI, disadvantages, and challenges b) Embryo transfer technology (MOET) - introduction, principle, detailed steps involved including embryo recovery, evaluation, preservation c) Somatic and Reproductive cloning – concept, history, and types. Somatic cell nuclear transfer, story of Dolly & associated challenges.	12
UNIT III Transgenic Animals a) Introduction to transgenesis; Objectives & Application of transgenesis b) Production of transgenic Mammals - Mice, Cow, Sheep, & Goat: applications with specific examples c) Production of transgenic Bird, Insects and Fishes; applications with specific examples d) Production of useful proteins in transgenic animals and molecular farming	12
UNIT IV Genetic Modification in Medicine e) Role of animal model in experimentation (disease model, drug assessment model, therapeutic cloning)	11

f) Introduction and Principle of Gene therapy, Gene Therapy Strategies (gene augmentation therapy, targeted killing of specific cells, targeted mutation correction, targeted inhibition of gene expression), Approaches of gene transfer in gene therapy (ex-vivo and in-vivo) g) Introduction to Stem Cell Technology and its applications.	

List of Practicals

1. Preparation of animal cell culture media.
2. Preparation of primary cell culture from fresh animal tissue (liver).
3. Dye exclusion assay- Trypan blue assay and cell counting using hemocytometer.
4. Isolation of PBMCs from whole blood using density gradient medium centrifugation process.
5. Preparation of in-vitro culture of isolate human PBMCs.
6. To demonstrate the protocol of freezing, cryopreservation and thawing of primary culture.
7. Genomic DNA extraction from animal cells
8. Demonstration of working model on ex-vivo and in-vivo gene therapy.

Part C-Learning Resources

1. Bernard R. Glick, Jack J. Pasternak, Cheryl L. Patten, Molecular Biotechnology: Principles and Applications of Recombinant DNA (4th edition)
2. B. D. Singh, Biotechnology: Expanding Horizons (4th edition)
3. Tom Strachan & Andrew P. Read, Human Molecular Genetics, 2nd edition. Garland Science, (2004)
4. R. Ian Freshney, Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications (6th Edition)
5. T. A. Brwon Gene Cloning and DNA analysis

SEMESTER-V

INTERDISCIPLINARY - BIOTECHNOLOGY

Semester	**V**
Name of the CourseID13: 250/BIOT/CC501	**Introduction to Bioinformatics**

Course Learning Outcomes (CLO):

After completing this course, the learner will be able to:

1. Search various biological database and extract biologically relevant information

2. Perform pair-wise and multiple sequence alignment

3. Search sequence database to identify homologous sequences in other organisms

4. Predict secondary and tertiary structure of proteins

5.Predict gene, promoter and regulatory elements

6.Compare genomes and build phylogenetic tree.

Credits	Theory	Practical	Total
	3	1	4
Contact Hours	3	2	5
Max. Marks: 100 (50TE+ 25TI + 05 PI + 20PE)	**Time: 2h (Theory), 2h (Practical)**		

Part B- Contents of the Course

Instructions for Paper-Setter

Nine questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining eight questions will be set taking two questions from each unit. The candidates will be required to attempt Q.No.1 & four others selecting one question from each unit. All questions carry equal marks.

	CONTACT HOURS
UNIT I Bioinformatics: definition, scope, goals, and major applications Introduction to databases: definition and basic concepts, types of biological databases- primary, secondary, composite and specialized, Limitations of biological databases: redundancy and annotation errors.	**12**

Overview of NCBI. Major biological databases (overview only): Nucleotide (GenBank, ENA, DDBJ); Protein (Uniprot KB: Swissprot, TrEMBL.); Literature (PubMed); Basic information retrieval from databases (keyword-based search). File formats: FASTA; GenBank, EMBL, Uniprot flat files	
UNIT II: Sequence Alignment & Database Searching Concept of similarity, identity and homology; Pairwise sequence alignment: global and local alignment, Dot Matrix, Dynamic Programming, concepts of general and affine gaps penalty, scoring matrices (PAM, BLOSUM) Multiple sequence alignment: concept, scoring function, Methods of multiple sequence alignment, practical issues, Introduction to identification of motifs/domains using MSA. Motif and domain databases Database Similarity Searching: BLAST (Algorithm, types, and interpretation of its result) and FASTA (Algorithm); comparison of BLAST and FASTA.	**12**
UNIT II: Gene Prediction & Structural Bioinformatics Gene prediction: prokaryotes vs eukaryotes, Methods: ab initio and homology-based; Prediction of Promoter and regulatory Elements in prokaryotes and eukaryotes Protein families (overview), Protein structure databases: PDB, SCOP, CATH, Structural classification: fold, superfamily, family, Structure visualization: PyMOL, UCSF ChimeraX	**10**
UNIT IV: Molecular phylogenetics: Basics of molecular evolution and key terminology, Gene phylogeny vs species phylogeny, Forms of Tree Representation, Tree construction methods: Distance-based (Neighbor-Joining (NJ), UPGMA), Character-based: Maximum Parsimony, Maximum Likelihood, Phylogenetic Tree Evaluation Methods: Bootstrap and Jackknife, Common Phylogenetic tools	**11**
List of Practicals 1. Exploration of NCBI and its resources.	

2. Retrieval and analysis of DNA and Protein sequences from Genbank and Swissprot databases.
3. Literature Search and Retrieval of Scientific Publication using PubMed.
4. Pairwise Sequence alignment and Interpretation of results using BLAST.
5. Multiple sequence alignment of biological sequences using simple tools (Clustal).
6. Exploration of PDB databases for protein structure analysis.
7. Visualization of protein structure from PDB using Pymol
8. Exploration and construction of Phylogenetic tree for evolutionary analysis
9. Performing DOTPLOT on web.
10. Gene prediction and identification of Exons using GLIMMER and GenScan

Part C-Learning Resources

1. *Essential bioinformatics* by Xiong, Jin
2. "Introduction to Bioinformatics" by S. Jawahar and S. Arumugam.
3. "Bioinformatics: A Practical Handbook" by Rashmi S. Shenoy and Ajay S. Verma.
4. "Bioinformatics: Concepts, Skills, and Applications" by Rastogi S. C.
5. "Practical Bioinformatics" by B. Jayaram and R. K. Shyamasundar.
6. "Bioinformatics For Dummies" by Jean-Michel Claverie and Cedric Notredame.
7. "Introduction to Bioinformatics" by Arthur M. Lesk
8. "Understanding Bioinformatics" by Marketa J. Zvelebil and Jeremy O. Baum.
9. "Bioinformatics for Beginners: Genes, Genomes, Molecular Evolution, Databases and Analytical Tools" by Supratim Choudhuri.

Semester	**V**
Name of the CourseID14: 250/BIOT/CC502	**Fundamentals of Genomics and Proteomics**
Course Learning Outcomes (CLO):	

After completing this course, the learner will be able to:
Understand the organization of genomes in prokaryotes and eukaryotes.
Differentiate between various generations of sequencing technologies
Use genome databases and gain insights into functional genomics
Understand protein structure, proteomics workflows including protein separation, identification, and quantification approaches.
Integrate genomic and proteomic knowledge for applications in biomedical research, diagnostics, and drug development.

Credits	Theory	Practical	Total
	3	1	4
Contact Hours	3	2	5
Max. Marks: 100 **(50TE+ 25TI + 05 PI + 20PE)**	**Time: 2h (Theory), 2h (Practical)**		

Part B- Contents of the Course

Instructions for Paper-Setter

Nine questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining eight questions will be set taking two questions from each unit. The candidates will be required to attempt Q.No.1 & four others selecting one question from each unit. All questions carry equal marks.

	CONTACT HOURS
UNIT 1 **Introduction to genomics:** scope, types **Genome Structure:** Comparative organization of prokaryotic and eukaryotic genomes, Repetitive DNA, Transposons (IS elements in bacteria, AC-DS in Maize, SINES and LINES in Humans), Organelle genomes (Mitochondria and Chloroplasts) **Sequencing Technologies:** Classical Methods: Sanger and Maxam-Gilbert sequencing; Next-Generation Sequencing (NGS): Pyrosequencing, Nanopore sequencing (overview and principles)	**12**

Genome Sequencing: Shotgun vs. Hierarchical strategies; Genome Assembly Basics; Human Genome Project	
UNIT II: **Web based servers for genome analysis:** ENSEMBL, UCSC Genome Browser, NCBI genome. Selected Model Organism's Genomes and Databases **Transcriptome and different methods to study gene expression:** Northern blots, qPCR, SAGE, MPSS and Microarray. (Overview of each) **Applications of Genomics:** Comparative genomics: comparison of genomes; pharmacogenomics: variable drug response of individuals; metagenomics-pathogen genomics (intro); epigenomics: New tool in studying complex disease	**12**
UNIT III: **Introduction**: to proteome and proteomics, types of proteomics (expression, structural and functional proteomics) **Protein structure:** Primary, secondary, tertiary and quaternary structure, Ramachandran Plot. Physical interactions that determine the property of proteins: Short range interactions, electrostatic forces, van der waal interactions, hydrogen bonds, hydrophobic interactions. **Protein separation techniques:** SDS-PAGE (principle, molecular weight estimation); 2D gel electrophoresis; Gel permeation chromatography	**10**
UNIT IV: **Protein identification strategies:** protein identification by antibodies (Western Blotting, microarrays), protein sequencing determination by Edman degradation, Mass spectrometry for protein identifications – Fundamentals, MALDI-TOF, peptide mass fingerprinting and De Novo sequencing (overview)	**11**

Protein-Protein Interaction: Yeast two-hybrid; Phage display, Co-immunoprecipitation (Co-IP), Protein/Antibody microarrays, Pull-down assays

Application of Proteomics: Biomarker discovery for disease diagnosis (Cancer); Proteomics in drug discovery and development, Applications of proteomics in agriculture

List of practical:

1. **Genomic DNA Isolation:** Extraction from plant/microbial/human blood sources.
2. **Quality Assessment:** Quantification of DNA and Agarose Gel Electrophoresis.
3. **Genomic Data Mining:** Retrieve human/microbial genome sequences from NCBI/Ensembl/UCSC Genome Browser.
4. **In-Silico Annotation:** Finding ORFs in nucleotide sequence using NCBI ORF Finder.
5. **Comparative Analysis:** Use **BLAST** and **ClustalW** for ortholog/paralog identification.
6. ***In silico* Primer Designing: using NCBI** Primer BLAST and *insilico* PCR.
7. **Polymerase Chain Reaction (PCR):** setting up reaction for a specific gene segment.
8. **Protein Extraction and Estimation:** Total protein isolation from bacterial/plant/animal source and quantification using Bradford/Lowry assay.
9. **SDS PAGE:** Separation of proteins by SDS PAGE.
10. **2D PAGE:** Demonstration of 2D PAGE and data analysis.

Part C-Learning Resources

1. Brown, T. A. (2017). Genomes 4. New York, NY: Garland Science (Taylor & Francis Group).
2. Primrose, S. B., & Twyman, R. M. (2006). Principles of Genome Analysis and Genomics. Oxford, UK: Blackwell Publishing.
3. Krebs, J. E., Goldstein, E. S., & Kilpatrick, S. T. (2018). Lewin's GENES XII (12th ed.). Burlington, MA: Jones & Bartlett Learning.
4. Snustad, D. P., & Simmons, M. J. (2015). Principles of Genetics (7th ed.). Hoboken, NJ: John Wiley & Sons.
5. Klug, W. S., Cummings, M. R., Spencer, C. A., & Palladino, M. A. (2019). Concepts of Genetics (12th ed.). New York, NY: Pearson.
6. Twyman, R. M. (2013). Proteomics: The Principles and Practice of Proteome Analysis. New York, NY: Garland Science.

7. Liebler, D. C. (2002). Introduction to Proteomics: Tools for the New Biology. Totowa, NJ: Humana Press.
8. Pevsner, J. (2015). Bioinformatics and Functional Genomics (3rd ed.). Hoboken, NJ: John Wiley & Sons.
9. Campbell, A. M., & Heyer, L. J. (2020). Discovering Genomics, Proteomics and Bioinformatics (3rd ed.). Boston, MA: Cengage Learning.
10. Gupta, P. K. (2016). Genomics. New Delhi, India: Rastogi Publications.
11. Rastogi, S. C., Mendiratta, N., & Rastogi, P. (2013). Bioinformatics: Methods and Applications—Genomics, Proteomics and Drug Discovery (4th ed.). New Delhi, India: PHI Learning.
12. Dubey, R. C. (2014). A Textbook of Biotechnology. New Delhi, India: S. Chand Publishing.

Part A - Introduction			
Semester	**V**		
Name of the Course ID15: (250/BIOT/CC503)	**Introduction of Environment Biotechnology**		
Course Learning Outcomes (CLO): On successful completion of the course the students will gain and be able to demonstrate following knowledge: 1. The students will understand the principles and applications of environment biotechnology for human welfare. They will be able to analyse environmental problems using modern biotechnological tools and mitigate the related issues using biotechnological interventions. 2. The students will be able explore biotechnological applications in waste management and bioremediation for sustainable development and human welfare. 3. The pupil will be able to develop practical skills in using biotechnological tools for environmental applications. 4. The students will be able to design and implement biotechnological solutions for sustainable agricultural practices, including the use of biofertilizers and biopesticides. 5. The students will be able to design sustainable biotechnology-based environmental interventions.			
Credits	**Theory**	**Practical**	**Total**
	3	1	4

Contact Hours	3	2	5
Max. Marks: 100 **(50TE+ 25TI + 05 PI + 20PE)**	**Time: 2h (Theory), 2h (Practical)**		

Part B- Contents of the Course

Instructions for Paper-Setter

Nine questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining eight questions will be set taking two questions from each unit. The candidates will be required to attempt Q.No.1 & four others selecting one question from each unit. All questions carry equal marks.

	CONTACT HOURS
Unit I. Fundamentals of Environmental Biotechnology • Introduction to environment and environment biotechnology, Scope and applications of the subject. • Role of microorganisms in nutrient cycling (Carbon, Nitrogen and Sulfur cycles) • Terminologies: Carbon tax, Carbon footprint, Carbon sequestration, natural carbon sinks, 3R's and green future in sustainability • Global environmental problems and runaway climate effects; Environmental pollution types and causes (air, water, soil and noise), Climate change; Green house gases, Ozone depletion and Global warming, Ocean acidification and ecological imbalance, global biodiversity loss. Case study of Claire Patterson regarding climate injustice awareness	**12**
Unit II. Waste management technologies	**12**

• Microbial Principles of Biodegradation (hydrocarbons, pesticides, herbicides etc) • Municipal, agriculture, industrial and nuclear wastes • Wastewater treatment technologies (primary, secondary, tertiary treatment) • Solid waste treatment: sources and management (composting, vermicomposting and methane production, landfill, hazardous waste treatment) • Brief outline of biotechnological interventions in nuclear/radioactive waste treatment.	
Unit III. Ecological restoration through Bioremediation • Overview of Bioremediation (using microbes, plants and fungi), types (in situ and ex situ bioremediation & Intrinsic versus engineered bioremediation), Advantages and disadvantages of bioremediation • Techniques and strategies of bioremediation (Bioventing, biosparging, bioaugmentation, biostimulation, biosorption, bioaccumulation) • Phytoremediation of degraded ecosystems like polluted land, air, soil and water; Case study of Vetiver grass biotechnology for environment restoration.	**10**
Unit IV Ecologically safe products and processes. • Idea of biopolymers, Biosurfactants, bioplastics and biodegradable materials. • Role and applications of microbes as biofertilizers (biological nitrogen fixation), biopesticides (Thuringiensis toxin as an example). • Mining and metal biotechnology processes: microbial transformation, bioleaching and extraction. • Brief introduction of Microbially Enhanced Oil Recovery (MEOR) • Integrated waste management (production of biomass, biogas and biofuel from waste) • Environmental significance of genetically modified microbes, plants and animals.	**11**
List of Practicals:	

1. Biochemical analysis of water and soil sample.
2. Microbial analysis of water sample.
3. To determine pH. TDS and turbidity of water sample
4. Determination of Dissolved oxygen and BOD of water sample.
5. Isolation of rhizobium from root nodules of leguminous plant.
6. Simulation of compost making for the utilization of organic waste.
7. Explore and submit an assignment on biocomputation and its impact on environment.
8. Field visit to any nearby wastewater treatment plant/ Biogas plant/composting plant/ wetland or forest-patch data collection and prepare a report.

Part C-Learning Resources

1. Rajiv K Sinha & Rohit K Sinha 2008. Environmental Biotechnology. Aavishkar publishers, Jaipur
2. Evans, G.G. & Furlong, J. 2010. Environmental Biotechnology: Theory and Application (2nd edition). Wiley-Blackwell Publications.
3. Jordening, H.J. & Winter J. 2005. Environmental Biotechnology: concepts and Applications. John Wiley & Sons.
4. Rittman, B.E. & McCarty, P.L. 2001. Environmental Biotechnology. Principles and Applications. McGraw-Hill, New York.
5. U Satyanarayan 2005. Biotechnology, Uppapatla author- publisher interlinks.
6. Indu Shekhar Thakur. 2011. Environmental Biotechnology: Basic Concepts and Applications, I K International Publishing house, N Delhi.
7. Chauhan S & Singh M (2024). Introduction to Biotechnology. Shree publishers, N Delhi.
8. Anmolka Jaini 2024. Introduction to Biotechnology. Google play books.

SEMESTER-VI

INTERDISCIPLINARY - BIOTECHNOLOGY

Part A - Introduction			
Semester	**VI**		
Name of the Course ID16: (250/BIOT/CC601)	**Introduction of Plant Biotechnology**		
Course Learning Outcomes (CLO): After completing this course, the learner will be able to: 1. Understand the basic concept and significance of Plant Tissue culture for the production of new varieties 2. Students will understand the importance of Plant Tissue Culture in various aspects, such as culture conditions, culture media, organo-genesis, somatic embryo-genesis, micro-propagation, and the importance of Haploids, etc., for the production of novel traits 3. Students will learn various plant vector constructs used in Plant Biotechnology for the production of transgenic plants for example, insect, herbicide resistance, etc. 4.Finally, students will understand the importance of Plant Biotechnology in reducing the time gap to produce new plant varieties with novel traits compared to normal plant breeding techniques			
Credits	**Theory**	**Practical**	**Total**
	3	1	4
Contact Hours	3	2	5
Max. Marks: 100 100 (50TE+ 25TI + 5 PI + 20PE)	**Time: 2h (Theory), 2h (Practical)**		

Part B- Contents of the Course	
Instructions for Paper-Setter Nine questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining eight questions will be set taking two questions from each unit. The candidates will be required to attempt Q.No.1 & four others selecting one question from each unit. All questions carry equal marks.	
UNIT 1 **UNIT I:**	**CONTACT HOURS** **10**

Introduction of Tissue culture and application to produce novel plant varieties and hybrids. Growth regulators. Introduction to the processes of embryo-genesis and organo-genesis and their practical applications. Clonal multiplication in plant species (Micro-propagation) and applications. Haploids and their applications. Somaclonal variations and applications in plant	
UNIT II: Introduction of Suspension Cultures and their types. Isolation of a single cell and its application in plant biotechnology. Somatic Hybridization and Applications: Protoplast Isolation, Protoplast fusion, Selection of hybrids. Type of hybrids, Cybrids and Artificial Seeds Embryo culture, embryo rescue after wide hybridization and its applications	**12**
UNIT III: Introduction of Plant Vectors: Plasmid Vector(Ri,Ti), Virus Vectors(Cauliflower Mosaic Virus, Gemini Virus, Tobacco Mosaic Virus). Direct and indirect methods of transformation (Particle Gun method, Electro-poration, Chemical methods, Micro-injection, Fiber-mediated gene transformation, Basics of Agrobacterium-mediated gene transformation: concept of co-culture, in planta transformation, transformation of soil-grown plants), chloroplast transformation	**12**
UNIT IV: Applications of Plant Biotechnology in varietal-improvement: insect resistance (BT Cotton), Virus resistance, Herbicide resistance: Modification in seed and protein quality, Golden Rice, Terminator gene technology, Delay in fruit ripening. Bio-safety measures related to transgenic Plants: Risk assessment, Risk groups, Containment System (Biological and physical), Levels of Bio-safety.	**11**

List of practical:

1. Preparation of stocks of macro-nutrients, micro-nutrients, vitamins and hormones for Murashige and Skoog medium.
2. Preparation of Murashige and Skoog medium.
3. Surface-sterilization of seeds/explants.
4. Sterilization techniques: Theory and Practical: Glassware sterilization, Media sterilization, Laboratory sterilization.
5. To Perform Micro-propagation from Explant
6. To initiate and establish callus culture
7. Preparation of Somatic hybrids using Tissue culture technique
8. Preparation of Artificial Seeds
9. To extract genomic DNA/Plasmid from a plant sample.
10. Isolation of protoplast from a plant leaf and perform protoplast fusion
11 Transformation of plasmid into a plant cell by electroporation
12 A visit to a Plant Research Center.

Part C-Learning Resources

1.Plant Tissue Culture: Theory and Practice. S.S. Bhojwani, M.K. Razdan Elsevier.
2.Plant Biotechnology: The genetic manipulation of plants. A. Slater, N. Scott and M. Fowler, Oxford University Press, 2008.
3.Plant Biotechnology- Principles And Applications. M. Z. Abdin: Springer, 2017
4.P. K. Gupta Plant Biotechnology, Rastogi Publication, Meerut, India
5 Singh B. D. Biotechnology: Expanding Horizon (2010) 3rd edition. Kalyani Publications
6 Old R.W, Primrose S.B, Twyman R. M, Principles of Gene manipulation (6th ed.)

Part A - Introduction	
Semester	**VI**
Name of the Course ID17: 250/BIOT/CC602	**Introduction to Bioprocess Technology**
Course Learning Outcomes (CLO):	

On successful completion of the course the students will gain and be able to demonstrate following knowledge:

1. Screen and isolate beneficial microorganisms from the environment.
2. Understand about strain improvement techniques.
3. Understand the parts and design of fermenter.
4. Gain theoretical knowledge on production of microbial products.
5. Gain knowledge about different techniques of fermentation, product recovery.
6. Gain knowledge about different microorganisms important in food industry

Credits	Theory	Practical	Total
	2	2	4
Contact Hours	2	4	6
Max. Marks: 100 (35TE+15TI+15PI+35PE)	**Time: 2h (Theory), 4h (Practical)**		

Part B- Contents of the Course

Instructions for Paper-Setter

Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking two questions from each unit. The candidates will be required to attempt Q.No.1 & three others selecting one question from each unit. Question no. 1 carry 8marks and other questions carry 9 marks each.

	CONTACT HOURS
Unit 1: Concept of Fermentation in industrial processes 1.1 Chronological developments in industrial processes. The fundamental concept of Fermentation and bioprocess technology 1.2 Types of processes: batch, Fed-batch and continuous culture process. 1.3 Strain isolation, screening techniques- primary and secondary & strain improvement of industrially important microorganisms- Mutation, Recombination and protoplast fusion. 1.4 Media for industrial fermentation. 1.5 Sterilization of fermenter & media, inoculum development, Cell immobilisation.	**10**

Unit II. Bioreactors-design, types and operation 2.1 Design and parts of fermenter - body construction- impeller, sparger, baffles, biosensors. 2.2 Agitation and aeration in the bioreactor viz. Mass transfer in bioprocess, factors affecting mass transfer. 2.3 Types of bioreactors, working and applications. 2.4 Commercial production of products- Raw materials, organism and industrial process involved in production of Bioethanol, Amylase and Pennicillin.	**10**
Unit 3: Downstream processing 3.1 Downstream processing: Typical steps involved in Downstream processing 3.2. Methods for cell breakage for harvesting intercellular products 3.3. Physical separation, liquid-liquid extraction, 3.4. Precipitation, chromatography, drying etc. 3.5 Criteria for downstream processing.	**10**
List of Practicals: 1. Yeast Cell immobilization. 2. Isolation of amylase producers. 3. Isolation of microbes producing antibiotics by crowded plate technique. 4. Bioassay of antibiotic. 5. Production of alcohol in laboratory. 6. Demonstration of fermentation by yeast. 7. Isolation of Amylase producers. 8. Amylase production by SSF. 9. Bioassay of amylases produced in lab.	

10. Industrial Visit.

Part C-Learning Resources

- Industrial Microbiology - L.E. Casida,JR (ISBN 0 85226 1012).
- Industrial Microbiology-A.H.Patel (ISBN 0333 90842 2).
- Prescott & Dunn's Industrial Microbiology Reed G (Ed) ISBN 81-239-1001-0) (Fourth Edition).
- Manual of Industrial Microbiology And Biotechnology, Demin & Davis. Srivastva, M.L. 2008. Fermentation Technology, Narosa Publ. House, New Delhi.
- Michael. J. Waites, Neil L. Morgan, John S. Rockey and Gray Higton. 2001. Industrial Microbiology An Introduction, Replika Press Pvt Ltd. New Delhi.
- Wulf Crueger and Anneliese Crueger. 2000. A textbook of Industrial Microbiology II Ed. Panima Publishing Corporation, New Delhi.
- Dubey R C and Maheswari, D K (2002). Practical Microbiology. S. Chand & Co Ltd. (ISBN 81-219-2153-8)
- Experiments in Microbiology, Plant Pathology and Biotechnology- K. R. Aneja.
- https://www.onlinebiologynotes.com/different-fermentation-pathway-bacteria/
- https://www.biologydiscussion.com/industrial-microbiology-2/strain-improvement-of-microorganisms-microbiology/66010 https://www.biotechnologynotes.com/industrial-biotechnology/fermentation process/downstream-process-in-fermentation-with-methods-industries-biotechnology/13671

Part A - Introduction	
Semester	**VI**
Name of the Course ID18: 250/BIOT/CC603	Bioethics IPR and Entrepreneurship
Course Learning Outcomes (CLO):	

After completing this course. the learner will be able to:

1. Understand the concept of Intellectual Property Rights and interpret IP Laws, patent filing process and biotechnology related legal framework.

2. Students will understand the importance of agencies like Word Trade organization and its importance for regulation of trade.

3 Student will understand entrepreneurship/ startup-ecosystem.

4. Student will able to analyse the ethical and social responsibilities of life scientists with reference to the responsible conduct of research and other work

Credits	Theory	Practical	Total
	2	1	3
Contact Hours	2	2	4
Max. Marks: 100 (35TE+15TI+5PI+20PE)	**Time: 2h (Theory), 2h (Practical)**		

Part B- Contents of the Course

Instructions for Paper-Setter

Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking two questions from each unit. The candidates will be required to attempt Q.No.1 & three others selecting one question from each unit. Question no. 1 carry 8marks and other questions carry 9 marks each.

	CONTACT HOURS
UNIT I: Introduction to Intellectual Property Rights (Patents, Copy rights, Trade mark, Trade secret and Geographical indications) Indian Patent Law. World Trade Organization and TRIPS agreement and	**10**

its related intellectual property provisions. Intellectual/Industrial property and its legal protection in research, design and development. Patenting in Biotechnology, economic, ethical and depository considerations.	
UNIT II: Concept and function of Entrepreneurship: Type of Entrepreneurship, Various parameters for-establishment of of a industry: Selection of a product, design and development processes, economics on material and energy requirements, stock the product and release the same for making etc The basic regulations of excise: Demand for a given product, feasibility of its production under given constraints of raw material, energy input, financial situations export potential.	**10**
UNIT III: Bioethics – Necessity of Bioethics, different paradigms of Bioethics – National & International. Bio-ethical issues in transgenics, Animal experimentation and Ethics in India (CPCSEA), GMOs, Gene therapy and human cloning. Bioethics advisory committees (International Bioethics Committee (IBC) of UNESCO, International Association of Bioethics (IAB), EuropaBio. Human rights and biomedicine. Concept of Bio-entrepreneurship (Definition, scope and importance) Start-up Ecosystem in Biotechnology, Public - Private partnerships. National and International Funding Agencies (DBT, DST, Venture Capital etc)	**10**
List of Practicals: 1 Filing of Patent application in India	

2 To study various search tools and databases used for patenting 3 To study various steps to start up an industry 4 To study various case studies regarding IPR 5 A visit to a Pharma or Biotech Industry	

Part C-Learning Resources

1. Hisrich R D and Peters M P, "Entrepreneurship", (5th ed), Tata Mc Graw-Hill,2002.

2 Narayanaswamy S., Youth development in the new millennium, (1st ed), Discovery publishing house, 2003.

3.Satheesh. M. K. Biosafety and Bioethics, (1st edition), I.K. International publishing house pvt. ltd., 2008

Minor Course from the department for pool of the Courses in the University

(These courses are offered by each department for students of other departments/same department to gain a broader understanding beyond the major discipline)

Semester 1

Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
MIC-1	Fundamentals of Biotechnology	250/BIOT/MI1 01	1	-	2	1	-	1	2	5	20	5	20	50

Semester 2

Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
MIC-2	Introduction to Gene Cloning	250/BIOT/MI2 01	1	-	2	1	-	1	2	5	20	5	20	50

Semester 3

Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
MIC-3	Applications of Biotechnology	250/BIOT/MI3 01	3	-	2	3	-	1	4	25	50	5	20	100

	in Agriculture & Environment													

Semester 6

Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
MIC-6	Industrial Microbiology	250/BIOT/MIC 601	3	-	2	3	-	1	4	25	50	5	20	75

Minor Course

Semester	I
Name of the Course ID: 250/BIOT/MI101	**Fundamentals of Biotechnology**

Course Learning Outcomes (CLO):

On successful completion of the course the students will gain and be able to demonstrate following knowledge:

1. Understand the concepts of biotechnology and get an insight of how biotechnology is related to other sciences.
2. Gain knowledge about the scope and applications of biotechnology. Get an insight of scope and applications of biotechnology in agriculture, environment, food and pharma and other industries.
3. Gain knowledge about genetic manipulations; recombinant DNA technology and genetic engineering.
4. Gain knowledge about the role of biotechnology in Bioinformatics, Nanotechnology and other allied fields
5. Gain knowledge of structure, working, maintenance/calibration and safety measures during handling of biotech lab instruments and biochemicals. Also get insight of maintenance of aseptic conditions and proper disposal of biochemicals.
6. Gain knowledge about intellectual property rights and ethical issues related to biotechnology.

Credits	Theory	Practical	Total
Contact Hours	1	1	2
	1	2	3
Max. Marks:50 **Internal Assessment Marks: 10** (05 Theory + 05 Practical) **End Term Exam Marks: 40** (20 Theory + 20 Practical)	**Time: 2h (Theory), 2h (Practical)**		

Part B- Contents of the Course

Instructions for Paper-Setter

Seven questions will be set in all. Question No.1 comprising objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking five questions from each heading. The candidates will be required to attempt Q.No.1 & any three other questions. All questions carry equal marks.

	CONTACT HOURS
Biotechnology: Definition, different types and colors (white, red, green, blue) of biotechnology, biotechnology as an interdisciplinary pursuit, scope and future of biotechnology, Biotechnology research in India, Biotechnology in context of developing world. **Genetic engineering:** Introduction of genetic engineering and basic concept of genetically modified organisms. History of genetic manipulations. **Application of biotechnology:** Application of biotechnology in agriculture, food industry, pharmaceutical industry, forensic analysis, environment protection. **Role of biotechnology in allied fields:** Bioinformatics, Nanotechnology and Biosensor. **IPR and bioethics:** a brief account on Intellectual property rights and Ethical issues related to Biotechnology.	**15**

List of Practical:

1. To study the different methods of sterilization and maintenance of aseptic conditions of biotech labs.
2. Study of structure, working and maintenance of lab instruments: Autoclave, Hot air oven, pH meter, Laminar airflow and centrifuge.

3. To study working, maintenance, calibration and precautions during handling of pH-meter, weighing balance, microscopes and other miscellaneous biotech lab instruments.
4. Preparation of normal, molar, percent solutions.
5. Preparation of buffer solutions and determination of their pH.
6. Precautions in handling of biochemicals and study of their proper disposal after use.
7. Visit to biotechnology lab.

Part C-Learning Resources

1. Biotechnology: expanding horizons- B. D. Singh
2. Elements of Biotechnology- PK Gupta
3. Biotechnology for beginners– Reinhard Renneberg Academic Press
4. BBB: Basics of Biology and Biotechnology- NM Jain
5. Introduction to Biotechnology-NM Jain
6. Biotechnology 5th edition- Johan E. Smith

Part A - Introduction			
Semester	**2**		
Name of the Course ID: 250/BIOT/MJ201	**Introduction to Gene Cloning**		
Course Learning Outcomes (CLO):			
After completing this course, the learner will be able to: 1. Understand concept and scopes of Genetic Engineering and role of recombinant DNA technology in all fields of Biotechnology. 2. Acquire the knowledge of basic concepts and methods for gene cloning, isolation, transformation and selection of desired clones. 3. Understand the concepts and methodology of PCR and its uses in diverse fields of life sciences. 4. Get acquainted with different tools and techniques used in Genetic Engineering experiments and manipulate DNA for its diverse use in different Biotechnology areas.			
Credits	**Theory**	**Practical**	**Total**
Contact Hours	1	1	2
	1	2	3

Max. Marks: 50 (5TI+ 20TE + 05PI + 20PE)	**Time: 2h (Theory), 2h (Practical)**

Part B- Contents of the Course

Instructions for Paper-Setter

Total six questions will be set. Question 1 comprising objective/ short answer type will be compulsory. The remaining five questions will be set from the entire syllabus. Students have to attempt total four questions including Q1 (compulsory) and three questions out of remaining five questions. All questions carry equal marks.

	CONTACT HOURS
• **Gene Cloning Vectors:** General features. Types of cloning vectors-Plasmid, bacteriophage, phagemid, cosmid. • **Gene Modifying Enzymes:** Restriction endonucleases (R.E.) Recognition sequence, blunt and sticky ends, applications. Ligases. Linker. Adaptor. Homopolymer tailing. Nick translation system. Construction of recombinant DNA. • **Gene Recombination and Gene transfer**: Preparation of competent cell. Gene transfer using Plasmids. Transformation. Selection of transformed cells. Selection and Screening of Recombinants • Direct selection. Preparation and comparison of Genomic and cDNA library • Principle and applications of Polymerase chain reaction (PCR) • **Applications of Genetic Engineering**	**15**

Practicals:

1. To perform plasmid isolation from *E.coli*
2. Isolation of genomic DNA from bacteria /plant
3. To perform PCR with given template and primers
4. To perform Restriction digestion of given DNA sample.
5. Performing alkaline phosphatase and ligation reaction of two DNA fragments.
6. Preparation of competent cells

7. Transformation of *E. coli* with foreign DNA.
8. Selection/screening of recombinant cells

Recommended Books/e-resources/LMS:

1. Singh B.D. Biotechnology: Expanding Horizon (2010)3rd edition. Kalyani Publishers.
2. Gupta P.K. Biotechnology and Genomics (2013)1st Edition. Rastogi publishers.
3. Gene cloning and DNA analysis An Introduction (2015) 7th edition, T.A Brown, Blackwell publisher.
4. Genome-3(2007) T .A Brown. Garland science, Taylor & Francis, NewYork.
5. Principles of gene manipulation and Genomics (2006) 7th edition, S. B Primose and R. Twyman, Blackwell publishing.
6. Molecular Cloning: A Laboratory Manual (2000), J. Sambrook, E. F. Fritsch and T. Maniatis, Cold Spring Harbor Laboratory Press, New York
7. DNA Cloning: A Practical Approach (1995), D. M. Glover and B. D. Hames, IRL Press, Oxford.

Part A - Introduction	
Semester	**III**
Name of the Course 250/BIOT/MI301	**Applications of Biotechnology in Agriculture & Environment**

Course Learning Outcomes (CLO):

On successful completion of the course the students will gain and be able to demonstrate following knowledge:

1. Understand the principles and applications of environment and agriculture biotechnology for human welfare. They will be able to better understand the scope and current market for environmental and agricultural biotechnology

2. The students will be able explore biotechnological applications in waste management and bioremediation for sustainable development and human welfare.

3. The pupil will be able to develop practical skills in using biotechnological tools for environmental applications.

and is focused on

4. The students will be able to design and implement biotechnological solutions for sustainable agricultural practices, including the use of biofertilizers and biopesticides.

5. The students will be able to utilize biotechnological tools and techniques for crop improvement. They will be able to learn and apply the strategies for the genetic modification of plants for enhanced traits such as pest resistance, drought tolerance, and improved nutritional content.

Credits	Theory	Practical	Total
	3	1	4
Contact Hours	3	2	5
Max. Marks: 100 (50TE+25TI+05PI+20PE)	**Time: 2h (Theory), 2h (Practical)**		

Part B- Contents of the Course

Instructions for Paper-Setter

Nine questions will be set in all. Question No.1 comprising objective/short answer type questions from the entire syllabus, will be compulsory. The remaining eight questions will be set taking three questions from each section. The candidates will be required to attempt Q.No.1 & four others selecting one questions from each section. All questions carry equal marks.

	CONTACT HOURS
Unit I. Introduction to Application of biotechnology in agriculture and environment. • Scope and applications of the subject. Role of biotechnology in environment conservation • Market for environmental and agricultural biotechnology, modalities and local influences in developing nations and global scenario. Prospects of potential job creation, start-ups and entrepreneurial ventures in the market	**10**

Gupta

• Overview of biotechnological tools and techniques for crop improvement (genetic engineering, plant tissue culture, micropropagation), pest management (Bioinsecticides, biopesticides), waste management (bioremediation, composting) and sustainable practices	
Unit II. Sustainable technologies. • Overview of the concept of green future including green technology, green energy, green infrastructure, green economy, and, green chemistry. • Sustainable consumption of resources. 3 R's of green technology: recycle, renew and reduce; paradigm shift from `cradle to cradle` to `cradle to grave • Principles of biotechnology, applications in agriculture. Waste to energy approaches; bioenergy from waste, value added products from organic waste. Alternate energy sources; First generation biofuels, second generation biofuels and third generation biofuels	**12**
Unit III. Ecological restoration techniques • Bioremediation definition and principle, types (in situ and ex situ bioremediation). Intrinsic versus engineered bioremediation, phytoremediation (plant based), mycoremediation (fungi based), techniques and strategies of bioremediation (Bioventing, biosparging, bioaugmentation, biostimulation, biosorption, bioaccumulation), slurry bioreactors. Advantages and disadvantages of bioremediation • Techniques and strategies of bioremediation (Bioventing, biosparging, bioaugmentation, biostimulation, biosorption, bioaccumulation), slurry bioreactors. Advantages and disadvantages of bioremediation	**12**

• Biotechnological interventions for solid waste treatment and management (composting, vermicomposting, methane production, landfill, hazardous waste treatment)	
Unit IV Agriculture Biotechnology applications • Role and applications of microbes in soil fertility and crop production (PGPR as biofertilizers (biological nitrogen fixation), biopesticides, bio-control of plant pathogens • Genetic modifications in Agriculture – transgenic plants, genetically modified foods (for enhanced nutrition, high yielding varieties, biotic and abiotic stress tolerant crops), applications of GM plants. • National and international guidelines (Cartagena Protocol), Ethical concerns of genetically modified microbes, plants and animals.	**11**

List of Practicals:

1. Biochemical analysis of water and soil quality
2. To determine TDS and turbidity of water sample
3. Determination of Dissolved oxygen, BOD and COD of water sample
4. Techniques in plant tissue culture (Preparation of Culture Medium, Sterilization, Preparation of Aseptic Plants, Aseptic Techniques and Incubation of Culture).
5. Agrobacterium tumefaciens-mediated plant transformation.
6. Preparation of root nodules from a leguminous plant and isolation of Rhizobium on YMA medium.
7. Simulation of compost making in lab conditions.
8. Students have to make use of Agriculture Biotechnology in waste management and conversion of waste to useful agri input/other useful products and submit project.

Part C-Learning Resources

1. Evans, G.G. & Furlong, J. 2010. Environmental Biotechnology: Theory and Application (2nd edition). Wiley-Blackwell Publications.

2. Jordening, H.J. & Winter J. 2005. Environmental Biotechnology: concepts and Applications. John Wiley & Sons.
3. Rittman, B.E. & McCarty, P.L. 2001. Environmental Biotechnology. Principles and Applications. McGraw-Hill, New York.
4. Scagg, A.H. 2005. Environmental Biotechnology. Oxford University Press.
5. Ahindra Nag , 2008 , Text Book Of Agricultural Biotechnology, PHI Learning
6. Shiva Aithal, Nikhilesh Kulkarni , 2010, Modern Approaches Soil Agriculture & Environmental Microbiology , Himalaya Publishing House

Part A - Introduction			
Semester	**VI**		
Name of the Course **250/BIOT/MI601**	**INDUSTRIAL MICROBIOLOGY**		
Course Learning Outcomes (CLO): On successful completion of the course the students will gain and be able to demonstrate following knowledge: 1. Screen and isolate beneficial microorganisms from the environment. 2. Understand about strain improvement techniques. 3. Understand the parts and design of fermenter. 4. Gain theoretical knowledge on production of microbial products. 5. Gain knowledge about different techniques of fermentation, product recovery. 6. Gain knowledge about different microorganisms important in food industry			
Credits	**Theory**	**Practical**	**Total**
	3	1	4
Contact Hours	3	2	5
Max. Marks:100 **(50TE+25TI+05PI+20PE)**	**Time: 2h (Theory), 2h (Practical)**		

Part B- Contents of the Course

Instructions for Paper-Setter

Nine questions will be set in all. Question No.1 comprising objective/short answer type questions from the entire syllabus, will be compulsory. The remaining eight questions will be set taking three questions from each section. The candidates will be required to attempt Q.No.1 & four others selecting one questions from each section. All questions carry equal marks.

	CONTACT HOURS
Unit 1: Concept of Fermentation in industrial processes 1.1 Historical developments in industrial processes. The fundamental concept of Fermentation and bioprocess technology 1.2 Types of processes: batch, Fed-batch and continuous culture process. 1.3 Strain isolation, screening techniques- primary and secondary & strain improvement of industrially important microorganisms- Mutation, Recombination and protoplast fusion. 1.4 Media for industrial fermentation. 1.5 Sterilization of fermenter & media, inoculum development, Cell immobilisation.	**12**
Unit II. Bioreactors-design, types and operation 2.1 Design and parts of fermenter - body construction- impeller, sparger, baffles, biosensors. 2.2 Agitation and aeration in the bioreactor viz. Mass transfer in bioprocess, factors affecting mass transfer. 2.3 Types of bioreactors, working and applications.	**12**
Unit 3: Downstream processing 3.1 Downstream processing: Typical steps involved in Downstream processing 3.2. Methods for cell breakage for harvesting intercellular products 3.3. Physical separation, liquid-liquid extraction, 3.4. Precipitation, chromatography, drying etc. 3.5 Criteria for downstream processing.	**10**

Unit IV: Bioprocess based products and application Range of Bioprocess technology. Commercial production of products: - raw materials. organism and industrial process involved in the production of 4.1. Bioethanol. 4.2. Lactic acid. 4.3. Amylase. 4.4. Penicillin. 4.5. Single cell protein.	**11**

List of Practicals:

1. Yeast Cell immobilization.
2. Isolation of amylase producers.
3. Demonstration of microbial antibiosis by crowded plate technique.
4. Demonstration of fermentation by yeast.
5. Bioassay of antibiotic.
6. Amylase production by SSF.

Part C-Learning Resources

- Industrial Microbiology - L.E. Casida,JR (ISBN 0 85226 1012).
- Industrial Microbiology-A.H.Patel (ISBN 0333 90842 2).
- Prescott & Dunn's Industrial Microbiology Reed G (Ed) ISBN 81-239-1001-0) (Fourth Edition).
- Manual of Industrial Microbiology And Biotechnology, Demin & Davis. Srivastva, M.L. 2008. Fermentation Technology, Narosa Publ. House, New Delhi.
- Michael. J. Waites, Neil L. Morgan, John S. Rockey and Gray Higton. 2001. Industrial Microbiology An Introduction, Replika Press Pvt Ltd. New Delhi.
- Wulf Crueger and Anneliese Crueger. 2000. A textbook of Industrial Microbiology II Ed. Panima Publishing Corporation, New Delhi.
- Dubey R C and Maheswari, D K (2002). Practical Microbiology. S. Chand & Co Ltd. (ISBN 81-219-2153-8)
- Experiments in Microbiology, Plant Pathology and Biotechnology- K. R. Aneja.
- https://www.onlinebiologynotes.com/different-fermentation-pathway-bacteria/

- https://www.biologydiscussion.com/industrial-microbiology-2/strain-improvement-of-microorganisms-microbiology/66010
  https://www.biotechnologynotes.com/industrial-biotechnology/fermentation process/downstream-process-in-fermentation-with-methods-industries-biotechnology/13671
-

Skill Enhancement Course from the department for pool of the Courses in the University

(These courses are offered by each department for students of other departments/same department and is designed to provide value-based and/or skill-based knowledge and should contain both theory and lab/hands-on/training/field work.)

Semester 1

Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
SEC-1	Dairy Processing	250/BIOT/SE/101	1	-	4	1	-	2	3	5	20	15	35	75

Semester 2

Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
SEC-2	Introduction to Cell Culture Techniques	250/BIOT/SE/201	1	-	4	1	-	2	3	5	20	15	35	75

Semester 6

Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total

SEC-3	Medical Laboratory Techniques	250/BIOT/SE 601	1	-	4	1	-	2	3	5	20	15	35	75

Skill Enhancement Courses

Part A - Introduction			
Semester		**I**	
Name of the Course ID: 250/BIOT/SE/	**101**	**DAIRY PROCESSING**	
Course Learning Outcomes (CLO): After completing this course, the learner will be able to: 1. The student will gain skills in dairy product development and hands-on training for the processing of different milk products. 2. The student can establish a startup based on their learnings in the subject. 3. The student can start provide 3rd party manufacturing to premiere dairy-based industries. 4. After completing this SEC, the student can work in any dairy based industry.			
Credits		**Theory**	**Practical**	**Total**
		1	2	3
Contact Hours		1	4	5
Max. Marks: 75 **(20TE+ 05TI + 15 PI + 35PE)**		**Time: 2h (Theory), 4h (Practical)**		

Part B- Contents of the Course

Instructions for Paper-Setter

Six questions will be set in all. Question No.1 comprising objective/short answer type questions from the entire syllabus, will be compulsory. The remaining five questions will be set from entire syllabus. The candidates will be required to attempt Q.No.1 & any three others questions. All questions carry equal marks.

Operation Flood –Definition of Milk and Nutritive value of milk and ICMR recommendation of nutrients –Per Capita Milk production and availability in India and Haryana State the need for processing milk. • Different types of Milks & its Products. • List the various units within a dairy processing plant • List the machineries used in a dairy processing plant Composition, Standards, Manufacturing - Process and Equipments for Manufacturing and Storage of Curd/Dahi, Yoghurt, Cheese and its types, Khoa, Paneer, Ghee and Ice Cream	**CONTACT HOURS** **15**

List of Practical:

1. Testing the quality of milk.
2. Processing of Flavoured milks.
3. Preparation of Dahi/Yoghurt.
4. Preparation of Ghee.
5. Preparation of Khoa/Paneer.
6. Preparation of Ice cream.
7. Sensory evaluation of Milk based products.
8. Milk based new product development.
9. How to plan a start-up, budgeting, marketing / case study/ entrepreneur (anyone of the above)?
10. Regulations, Licensing and registration of a start-up.
11. Visit to Dairy plant.

Suggested readings:

1. Dairy Science: Petersen (W.E.) Publisher – Lippincott & Company
2. Principles and practices of Dairy Farm –Jagdish Prasad
3. Text book of Animal Husbandry - G C Benarjee
4. Hand book of Animal Husbandry - ICAR Edition
5. Outlines of Dairy Technology – Sukumar (De) – Oxford University press

6. Indian Dairy Products – Rangappa (K.S.) & Acharya (KT) – Asia Publishing House.
7. The technology of milk Proccesing – Ananthakrishnan, C.P., Khan, A.Q. and Padmanabhan, P.N. – Shri Lakshmi Publications.
8. Dairy India 2007, Sixth edititon.
9. Economics of Milk Production – BharatiPratima Acharya Publishers.
10. http://www.asci-india.com/BooksPDF/Dairy%20Farmer%20or%20Entrepreneur.pdf
11. https://labour.gov.in/industrial-safety-health

Semester	**II**
Name of the Course: 250/BIOT/SE(201	**Introduction to CELL CULTURE TECHNIQUES**

Course Learning Outcomes (CLO):

1. Students will gain significant experience in handling the cells (microbial, animal & plant) through culture. Through integrated learning methods, utilizing hands-on training to reinforce lecture material participants will learn the biological basis and relevance of the process of culturing cells.
2. The course will provide in detail knowledge of basic instruments involved in culture laboratory, so that the students can easily be acquainted as operators in several cell culture & diagnostic laboratory.
3. In-hand experiments based on cell culture, development of slides, staining and analysis, along with documentation will impart experiential knowledge to students. The students in future can easily find way in cell culture & diagnostic laboratory.
4. Students will learn basics of plant propagation, learning massive propagation of plants now-a-days is very popular for profitable enterprise.

Credits	**Theory**	**Practical**	**Total**
	1	2	3
Contact Hours	1	4	5
Max. Marks:75 (20TE+ 5TI + 15 PI + 35PE)	**Time: 2h (Theory), 4h (Practical)**		

Part B- Contents of the Course

Instructions for Paper-Setter

Total six questions will be set. Question 1 comprising objective/ short answer type will be compulsory. The remaining five questions will be set from the entire syllabus. Students have to attempt total four questions including Q1 (compulsory) and three questions out of remaining five questions. All questions carry equal marks.

Introduction & biology of cultured cells; Equipment, aseptic techniques, safety protocols. Properties and uses of chemicals commonly used in cell culture laboratories. Culture vessels & media development (for animal cell culture); solid versus suspension culture. Different phases of cell growth (cell cycle concept and factors affecting cell growth in culture). Applications of cell culture Animal Cell Culture: Definition, cell lines, finite & continuous cell lines, culture conditions, Concept of Primary culture & secondary culture, preparation of primary culture (disaggregation of animal tissues via mechanical, enzymatic and EDTA). Plant Cell Culture: Overview of plant cell culture, plant cell growth in culture, isolation and culture of single cell, Callus culture and suspension culture, Protoplast culture, Storage and revival of cells.	**CONTACT HOURS** **15**

List of Practicals

1. Principle, working & precautions of several basic equipment of biotechnology lab (weighing balance, autoclave, laminar air flow, incubator, spectrophotometer, centrifuge, microscope).
2. Preparation of animal cell culture media.
3. Preparation of plant cell culture media.
4. Handling of cells *in-vitro*: Determination of cell growth, cell count and viability.
5. Preparation of primary cell culture using enzymatic approach in tissue disaggregation.
6. Preparation of primary cell culture using mechanical approach in tissue disaggregation.
7. To subculture a confluent primary culture in maintaining animal cell culture.

8. Isolation of single cell isolation for plant cell culture.
9. Culture of single cell isolation for plant cell culture.
10. To determine cell viability in plant cell culture.
11. To demonstrate protoplast isolation.
12. Visit to Animal and Plant Cell Culture Laboratories in University or Institute.

Part C-Learning Resources

a) Culture of Animal Cells by R Ian Freshney
b) Animal Cell Culture: Principles and Practice by Shalini Mani, Manisha Singh, Anil Kumar
c) Experiments In Microbiology, Plant Pathology and Biotechnology - K. R. Aneja
d) Plant cell culture protocols, - Victor M. Loyola-Vargas and Felipe Vázquez-Flota (2nd edition).
e) **https://microbenotes.com/animal-cell-culture/**
f) **https://www.sigmaaldrich.com/IN/en/technical-documents/technical-article/cell-culture-and-cell-culture-analysis/primary-cell-culture/primary-cell-culture?srsltid=AfmBOoqYZO_8NnANb6nJ00tSLuvaXD4MGqZlujPOkGW-jlrQhllizWXo**

Part A - Introduction			
Semester	**III**		
Name of the Course ID: 250/BIOT/SE 601	**Medical Laboratory Techniques**		
Course Learning Outcomes (CLO): After completing this course, the learner will be able to: • Demonstrate proficiency in laboratory safety, biomedical waste disposal, and standard protocols for collecting and transporting clinical specimens. • Explain the clinical significance and underlying principles of routine biochemical panels, including blood glucose, lipid profiles, and liver and renal function tests. • Perform and interpret fundamental hematological tests and diagnostic microbiology screens, including CBC, blood grouping, ELISA, and PCR-based assays.			
Credits	**Theory**	**Practical**	**Total**
	1	2	3
Contact Hours	1	4	5

Max. Marks:75 (20TE+ 05TI + 15 PI + 35PE)	Time: 2h (Theory), 4h (Practical)

Part B- Contents of the Course

Instructions for Paper-Setter

Six questions will be set in all. Question No.1 comprising objective/short answer type questions from the entire syllabus, will be compulsory. The remaining five questions will be set from entire syllabus. The candidates will be required to attempt Q.No.1 & any three others questions. All questions carry equal marks.

	CONTACT HOURS
· **Lab Safety & Ethics:** Good Laboratory Practices (GLP), Bio-safety levels (BSL), biomedical waste management · **Clinical Samples:** Types of specimens (blood, urine, stool, CSF), collection techniques (venipuncture), anticoagulants & transport protocols · **Biochemical Analysis:** Basic Information regarding Blood Glucose (Diabetes), Lipid Profile, Liver Function Tests (LFT), and Renal Function Tests (RFT). · **Haematology:** Composition of blood, Blood clotting mechanism, Mechanism of routine tests: CBC, ESR, and Blood Grouping. · **Diagnostic Microbiology & Immunology:** Basic principles of culturing clinical pathogens (urine culture) Overview of Serological tests: ELISA, Rapid Kits (Pregnancy, Typhoid, HIV), and PCR-based diagnostics(NS1- dengue)	15

List of Practical:

1. **Collection of Blood:** Demonstration of vacuum-based collection (Vacutainers) and finger-prick methods.
2. **Total Count:** Estimation of RBC and WBC using a Haemocytometer.
3. **Differential Leucocyte Count (DLC):** Preparation of blood smear, Leishman staining, and identification of cells.
4. **Haemoglobin Estimation:** Using Sahli's acid haematin method or Cyanmethaemoglobin method.
5. **Blood Grouping:** Determination of ABO and Rh factor (Slide / Tube method).
6. **ESR:** Determination of Erythrocyte Sedimentation Rate
7. **Blood clotting:** Determination of blood clotting time & bleeding time.
8. **Urine Analysis:** Physical, chemical (Glucose, Protein, Ketone bodies) examination
9. **Blood Glucose Estimation:** Demonstration using a Glucometer and Semi-autoanalyser.

10. Serological Tests:

- Widal Test for Typhoid (Slide Agglutination).
- VDRL/RPR for Syphilis
- Rapid Pregnancy Test (HCG).

Suggested readings:

- Textbook of Medical Laboratory Technology by Praful B. Godkar.
- Hand Book of Medical Laboratory Technology by V.H. Talib.
- Manual of Lab and Diagnostic Tests by Fischbach.

Vocational Course from the department for pool of the Courses in the University

(These courses are offered by each department for students of other departments/same department and is focused on practical work, preparing students for a particular skilled profession.

Semester 4

Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
VOC-1	Food Processing	250/BIOT/VOC 401	2	-	4	2	-	2	4	15	35	15	35	100

Semester 5

Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
VOC-2	Introduction to Molecular Diagnostics	250/BIOT/VOC 501	2	-	4	2	-	2	4	15	35	15	35	100

Semester 6

	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS

Course Code			(Hrs)			Credits				TI	TE	PI	PE	Total
VOC-3	Fundamentals of Medical Biotechnology	250/BIOT/VO 601	2	-	4	2	-	2	4	15	35	15	35	100

Part A - Introduction			
Semester	**IV MIC(VOC-1)**		
Name of the Course (250/BIOT/VO401)	**FOOD PROCESSING**		
Course Learning Outcomes (CLO): On completion of the course students are able to: 1) learn the basic principles, methods, and techniques used in food processing and preservation. 2) learn how these processes help in maintaining food quality, safety, and extending shelf life. 3) learn the impact of various preservation methods on the nutritional value and taste of food. 4) Suitable for self-employment and for placement in small scale units of food preservation and processing			
Credits	**Theory**	**Practical**	**Total**
	2	2	4
Contact Hours	2	4	6
Max. Marks: 100 100 (35TE+ 15TI + 15 PI + 35PE)	**Time: 2h (Theory), 4h (Practical)**		

Part B- Contents of the Course

Instructions for Paper-Setter

Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking two questions from each unit. The candidates will be required to attempt Q.No.1 & three others selecting one question from each unit. Question no. 1 carry 8marks and other questions carry 9 marks each.

	CONTACT HOURS
UNIT I **Introduction to Food Processing and Preservation-** Definition, Historical evolution, current status of food processing, scope and future of food processing, Primary vs. secondary processing, perishable and non-perishable foods, causes of food spoilage. **Preservation of foods by Preservatives**: chemicals (natural and synthetic), antioxidants, acidulates etc. **Preservation by non-preservatives:** salt-pickling, sugar-jams, jellies and marmalades **Preservation by radiation**: Definition, equipment, measurement of dose, effect on micro-organisms, effect on foods	10
UNIT II (a)**Thermal processing**: Canning (definition, time-temperature combination and equipments). **Blanching** (definition, steam blanchers, hot water blanchers, effect on foods-nutrient, colour, flavour and texture) **Pasteurization** (definition, pasteurisation of packaged food and unpackaged foods, effect on food- colour and flavour, vitamin loss) **Use of low temperature**: Chilling, cold storage, freezing Air freezing, plate freezing, liquid immersion freezing and cryogenic freezing. Freezer selection. Advantages and disadvantages of freezing and changes in food during freezing storage.	10
UNIT III **Preservation by drying**: Principle, Methods and effect on quality, sun/solar drying, Cabinet drying, tunnel dryer, spray dryer, freeze dryer, fluidized bed dryer. Nutritional, physico-chemical changes during drying.	10

Recent methods employed in preservation: (theory, equipment, effect on micro-organisms) of- Pulsed electric field processing, high pressure processing, processing using ultrasound, dielectric, ohmic and infrared heating.	

List of Practicals:

1. Tips for successful food processing practicals: hygiene, safety and record keeping
2. Experimenting with natural and artificial preservatives
3. Making food preserve using salt-pickling
4. Making fruit preserves, jams, jellies or marmalades.
5. Sun drying, air drying, or using a dehydrator for fruits, vegetables, and herbs.
6. Learn how blanching vegetables and fruits before freezing helps preserve their colour, texture, and nutritional value.
7. Performing shelf-life tests with different packaging methods
8. Visit to food processing unit

Part C-Learning Resources:

1. Food Processing: Principles and Applications by Ramaswamy H. & Marcotte M. Taylor & Francis.
2. NCERT textbook, chapter on food processing(https://ncert.nic.in/textbook/pdf/lehe104)
3. https://www.ficsi.in/blog/different-types-and-methods-involved-in-food-processing
4. Principles of Food Processing: Richard W Hartel. Dennis R. Heldman, Aspen publication
5. Food processing engineering and technology by Zeki Berk Professor, Elsevier publication
6. Food processing: principles and applications/edited by Scott Smith and Y.H Hui 1st Edition, Blackwell Publishing

Part A - Introduction	
Semester	**V MIC(VOC-2)**
Name of the Course (250/BIOT/VO501)	**Introduction to Molecular diagnostics**
Course Learning Outcomes (CLO):	

On completion of the course students are able to:
LO 1: Perform and analyze a standard karyotype to identify numerical chromosomal aberrations (such as Trisomies) and large-scale structural anomalies.
LO 2: Differentiate between G, R, Q, and C banding techniques based on their staining mechanisms, target chromatin types, and clinical diagnostic uses.
LO 3: Explain the unique mechanics and applications of specialized PCR variants, including qPCR for quantification and RT-PCR for viral RNA detection.
LO 4: Compare protein-based diagnostic tools (ELISA and DOT blot) with cell-sorting technologies (Flow Cytometry/FACS) regarding their principles and clinical markers.
LO 5: Apply molecular testing data to screen for inherited disorders and driver mutations, while evaluating the ethical, legal, and counseling responsibilities involved.

Credits	**Theory**	**Practical**	**Total**
	2	2	4
Contact Hours	2	4	6
Max. Marks: 100 100 (35TE+ 15TI + 15 PI + 35PE)	**Time: 2h (Theory), 4h (Practical)**		

Part B- Contents of the Course

Instructions for Paper-Setter

Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking two questions from each unit. The candidates will be required to attempt Q.No.1 & three others selecting one question from each unit. Question no. 1 carry 8marks and other questions carry 9 marks each.

UNIT I Cytogenetics and Nucleic Acid Fundamentals	**CONTACT HOURS**
• Chromosomal Architecture: General features and morphology; principles of Karyotyping for detecting numerical and structural aberrations.	**10**

• Banding Techniques: Mechanics and clinical correlates of G, R, Q, and C banding patterns. Hybridization Foundations: Western blotting; FISH, GISH, Chromosome painting.		
UNIT II **Advanced Amplification and Detection Technologies** • PCR Dynamics: Basic principles, components, and thermal cycling. • Specialized PCR Variants: qPCR, RT-PCR, hotstart PCR, Nested PCR, touchdown PCR • Proteomics in Diagnostics: Principles of ELISA for protein-based infection markers, DOT blot, RIA and an introduction to Flow Cytometry/FACS for cell sorting and analysis.	**10**	
UNIT III **Clinical Applications** • *Rapid Diagnostics kits- COVID-19, MDR-TB, dengue* • *Molecular Oncology: Identifying "Driver Mutations" in tumors - BRCA1/2* • Genetic Disorders & Carrier Screening: Molecular testing for inherited conditions- Thalassemia, Cystic Fibrosis • Genetic Counseling Considerations in Molecular Diagnosis, Ethical, Social, and Legal Issues Related to Molecular Genetic Testing.	**10**	
List of practical: 1. To prepare and analyze a human karyotype to identify numerical or structural chromosomal abnormalities 2. To differentiate between heterochromatic and euchromatic regions using G-banded and R-banded photographic slides or digital profiles. 3. To screen for microdeletions or gene amplifications (such as the *BRCA1* deletion or *HER2* amplification) using simulated or pre-captured fluorescent micrographs. 4. To set up a functional PCR master mix and program a thermal cycler to amplify a target DNA fragment. 5. To perform a qualitative/semi-quantitative Sandwich ELISA to detect an infection marker or antigen in a biological sample.		30

6. To detect a specific target protein directly immobilized on a nitrocellulose membrane without electrophoretic separation.
7. To perform and interpret a rapid immunochromatographic assay for antigen/antibody detection from mock clinical samples
   To interpret restriction enzyme cleavage profiles (RFLP) or specific band patterns to screen for carriers of autosomal recessive disorders.

Part C-Learning Resources:

- Wilson, K. and Walker, J. Practical Biochemistry – Principles and techniques 7th edition, 2010, Cambridge University Press.
- Primrose Sandy B. and Richard Twyman, Principles of Gene Manipulation and Genomics (7th Edition), Wiley-Blackwell 2006.
- Brown T. A. Gene Cloning and DNA Analysis: An Introduction, (6th Edition) Wiley-Blackwell, 2010.

Part A - Introduction			
Semester	**V MIC(VOC-3)**		
Name of the Course (250/BIOT/VO601)	**Fundamentals of Medical Biotechnology**		
Course Learning Outcomes (CLO): On completion of the course students are able to: 1: Explain human genetic and metabolic disorders and assess prenatal diagnostic strategies for their detection. 2: Categorize first- to fourth-generation vaccine platforms based on their design and immunological principles 3: Outline hybridoma technology and apply antibody engineering principles to clinical immunotherapies. 4: Evaluate advanced biotherapeutic modalities including gene therapy, recombinant proteins, and phage therapy.			
Credits	**Theory**	**Practical**	**Total**
	2	2	4
Contact Hours	2	4	6
Max. Marks: 100 100 (35TE+ 15TI + 15 PI + 35PE)	**Time: 2h (Theory), 4h (Practical)**		

Part B- Contents of the Course

Instructions for Paper-Setter

Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking two questions from each unit. The candidates will be required to attempt Q.No.1 & three others selecting one question from each unit. Question no. 1 carry 8marks and other questions carry 9 marks each.

	CONTACT HOURS
UNIT I • **Introduction** – Origin, significance & worldwide market of Medical Biotechnology. Revolution in clinical diagnosis. Antimicrobial resistance. • **Genetic Disorders** – Introduction, Classification, Impact of genetic diseases on human health - Chromosome errors - Down syndrome, Klinefelter's and Turner's syndrome. • **Metabolic disorders** – Phenylketonuria, Homocystinuris, Mucopolysaccharidosis, Gangliosidosis, Gaucher's disease, Diabetes, Hemophilia and sickle cell anemia, Polyendocrine Metabolic Ovarian Syndrome (PMOS), Treatment of Genetic diseases - prenatal diagnosis, Genetic Counseling - Ethical, Legal and Social Issues.	10
UNIT II • **Vaccines:** History, principles & mechanism of vaccination. Types of vaccines: 1st generation (live attenuated, killed), 2nd generation (toxoid, subunit, conjugate), 3rd generation (recombinant, DNA, mRNA, viral vector), and 4th generation (synthetic peptide, Nano-vaccines). • **Monoclonal Antibodies (mAbs):** Basic concepts of immunotherapy and the production and clinical applications of monoclonal antibodies. Hybridoma technique	10
UNIT III • **Gene Therapy:** Principles and strategies including gene augmentation, targeted killing of specific cells, and targeted mutation correction. Approaches of gene transfer: *ex-vivo* and *in-vivo*.. • **Revolution in treatment:** – Recombinant DNA technology for human insulin, Hepatitis B vaccine. Therapeutic proteins and peptides – Erythropoietin, Tissue plasminogen activator, clotting factor VIII. Antibody Engineering and Therapeutic Antibodies. Phage therapy for Antibiotic resistant strains.	10

List of practical: 1. Karyotyping of normal and abnormal human chromosome sets 2. Demonstration of ELISA for the detection of specific antigens or antibodies. 3. Isolation of genomic DNA from human/animal cells & Amplification of a target gene using PCR. 4. Performing Widal tests and blood grouping by agglutination. 5. Demonstration of working models on *ex-vivo* and *in-vivo* gene therapy. 6. Detection of DNA damage by comet assay 7. Genotyping of candidate genes for diseases by RFLP 8. Case Study: Analyzing the ethical implications of a hypothetical genetic engineering or cloning project. Preparation of a report on Good Laboratory Practices (GLP) and waste disposal in a medical biotechnology lab.	30

Part C-Learning Resources:

1. • Glick B.R. and Pasurank. Molecular biotechnology – Principle and Applications of Recombinant DNA- J.I (4th edition). ASM Press. 2010.
2. Anthony D. Ho. Hoffman. R. and Esmail D. Zanjani. Stem Cell Transplantation (4th edition). Wiley – liss publishers. 2006.
3. Hornyak. G.L. Moore. J.J. Tibbals H.F., Dutta. J. Fundamentals of Nanotechnology (1st edition). CRC press. 2008. Further Reading:
4. Jogdand. S. N. Medical Biotechnology –. (4th edition). Himalayan publishing house. 2004.

Freshney.I. Stacey. G. N. Auerbach.J.M. Culture of Human Stem Cells (1st edition). Wiley – Liss publishers. 2007.

Multidisciplinary Course from the department for pool of the Courses in the University

(These courses are to be offered to students of different discipline/Subject) Biotechnology

Semester 1

Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
MDC-1	Wonders of living organisms: Structural Insights	250/BIOT/MD 101	2	-	2	2	-	1	3	15	35	5	20	75

Semester 2

Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
MDC-2	Human Biochemistry and Genetics	250/BIOT/MD 201	2	-	2	2	-	1	3	15	35	5	20	75

Semester 3

Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
MDC-3	Power of Immune System	250/BIOT/MD 301	2	-	2	2	-	1	3	15	35	5	20	75

MULTIDISCIPLINARY COURSE - BIOTECHNOLOGY

Part A - Introduction	
Semester	**I**
Name of the Course ID: 250/BIOT/MD 101	**Wonders of living organism: structural insights.**

Course Learning Outcomes (CLO):

After completing this course, the learner will be able to:

1. Understand the origin of life and discovery of living cells.
2. Know about features of structures and purposes of basic components of prokaryotic and eukaryotic cells, their organelles, and facts about their working.
3. Students learn about basic animal and plant organization at the level of cell, tissue, organ, and organ system.
4. Learn practical skills on basic Biology practical like parts of microscope, slide preparation, identify plant and animal cells using models and specimens.

Credits	**Theory**	**Practical**	**Total**
	2	1	3
Contact Hours	2	2	4
Max. Marks:75 (35TE + 15TI + 20PE + 5PI)	**Time: 2 H (Theory), 2h (Practical)**		

Part B- Contents of the Course

Instructions for Paper-Setter

Seven questions will be set in all. Question No.1 comprising objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking two questions from each section. The candidates will be required to attempt Q No.1 & three others selecting one question from each section. Question 1 will be of 8 marks and remaining questions of 9 marks.

	CONTACT HOURS
Unit I: Structure and Function of Cell a) Cell theory, its origin and cell as the basic unit of life. Basic Structure of prokaryotic and eukaryotic cells (Plant cell and Animal cell) b) Cell organelles - mitochondria, chloroplast, ribosomes, endoplasmic reticulum, Golgi bodies, lysosomes, vacuoles, and nucleus. c) Cell cycle, mitosis, meiosis, and their significance	**10**
Unit II: Structural Organization of Animal Body a) Basic understanding of different levels of organization in animals (cellular level, tissue level, organ level, organ system level, organism level). Importance of level of organization in animals. b) Parameters of animal diversity (symmetry, diploblastic and triploblastic organization; Coelom; Notochord	**10**
Unit III: Structural Organization of Plant Body a) Levels of organization in plants (meristematic and permanent tissue; simple and complex plant tissue; shoot organ system and root organ system) b) Parts of a flower body and its function. c) Zones of roots and its types	**10**

List of Practical:

1. Study of simple compound microscope: its parts and focusing.
2. Study and compare the prokaryotic and eukaryotic cell.
3. Study and compare the animal and plant cell microscopic slides.
4. Study different stages of mitosis (microscopic view)
5. Compare different parameter of animal organization in hydra, star fish, frog, and human.
6. Study and describe different zones of roots.
7. Study types of roots (tap and adventitious).
8. Study and describe different structural component of *Hibiscus* flower
9. Study of leaf (arrangement, shape, venation, simple and compound).

Part C-Learning Resources

Suggested readings:

1. https://www.geeksforgeeks.org/levels-of-organization-in-animals/
2. Biology Text Book for class XI published by NCERT.https://ncert.nic.in/textbook.php?kebo1=0-19

Gupta

2. Fundamentals of Biology: CBSE Class 11 published by Wiley
3. I.S.C. Practical Biology (Including Viva-Voce & Project Work) Class- XIby V.P. Aggarwal and S.C. Maheshwari

Part A - Introduction			
Semester	**II**		
Name of the Course: 250/BIOT/MD201	**Human Biochemistry and Genetics**		
Course Learning Outcomes (CLO): After completing this course, the learner will be able to: 5. Students should grasp the basic knowledge and function of key biomolecules (proteins, carbohydrates, lipids, and nucleic acids). 6. Students learn about the different components of energy expenditure, recognize positive and negative energy balance, and planning of healthy diet 7. Analyze personal food intake and activity patterns to identify areas for improvement. 8. Students understand the principles of inheritance; genes interaction to produce phenotypes; role of genetic counselling			
Credits	**Theory**	**Practical**	**Total**
	2	1	3
Contact Hours	2	2	4
Max. Marks:75 (35TE + 15TI + 20PE + 5PI)	**Time: 2 H (Theory), 2h (Practical)**		

Part B- Contents of the Course

Instructions for Paper-Setter

Seven questions will be set in all. Question No.1 comprising objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking two questions from each section. The candidates will be required to

attempt Q.No.1 & three others selecting one question from each section. Question 1 will be of 8 marks and remaining questions of 9 marks.

Unit 1: Biochemical metabolism and architecture: a) overview of metabolism (catabolism and anabolism) b) Key characteristics & roles of carbohydrates in body (glucose vs fructose; starch, glycogen, and cellulose) c) Key characteristics & roles of Proteins in body (building blocks amino acids-essential vs non-essential; enzymes) d) Key characteristics & roles of nucleic acids (types, hereditary unit) e) Key characteristics & roles of lipids (Fats vs oil; cholesterol; energy storage)	**10**
Unit II: Energy Balance and Hormones a) Overview of energy balance, factors influencing energy balance, role of healthy diet and lifestyle in maintain energy balance) b) Obesity and BMR; influencing factors c) Lethargy, tiredness, and restlessness; causative factors d) Hormones (introduction & examples; role of hormones in controlling growth & development; mood & behavior; metabolism) e) role of diet in anxiety and stress management	**10**
Unit III: Genetics a) Basic knowledge of hereditary, genes, DNA, Chromosomes, mutations, alleles. b) Basic rules of genetics (concept of inheritance, genetic variations, genomics, gene expression in instructing message) c) Genes and Traits (physical and physiological traits; genotype vs phenotype; polygenic traits; hereditary diseases) d) Genetic counselling (definition, and importance) e) Gene- environment interaction	**10**
List of Practical: 1. To test the presence of carbohydrates in food sample.	

2. Ninhydrin test for detecting presence of protein in milk.
3. Identify and categorize the important biomolecules in your diet.
3. Construct a food pyramid for normal and obese person.
4. Prepare a healthy diet plan for growing child.
5. Construct a possible child blood group chart taking some examples.

Part C-Learning Resources

Suggested readings:

1. The text book on general biochemistry by Bhagat Y. S and his team.
2. Mark Lorch Biochemistry: A Very Short Introduction.
3. https://www.nhlbi.nih.gov/health/educational/wecan/healthy-weight-basics/balance.htm#:~:text=What%20is%20Energy%20Balance%3F,physical%20activity%20is%20ENERGY%20OUT.
4. Fundamentals Of Genetics and Molecular Biology, By Dr Vishnu Shankar Sinha

Part A - Introduction	
Semester	**III**
Name of the Course ID: 250/BIOT/MD301	**Power of Immune System**

Course Learning Outcomes (CLO):

After completing this course, the learner will be able to:

9. Students will understand the fundamental principles of the immune system, including its components, functions, and how it responds to threats, as well as the mechanisms of immune-related diseases and potential treatments.
10. Students will be able to differentiate between the innate (non-specific) and adaptive (specific) immune systems, including their respective mechanisms and roles.
11. Learn practical skills on basic immunological test. Understand the principles of blood typing, antibody-antigen interactions, and the importance of blood group compatibility in transfusions. Also, they

learn about the different types of leukocytes and their roles in the immune response, and how to interpret a differential leukocyte count.

Credits	**Theory**	**Practical**	**Total**
	2	1	3
Contact Hours	2	2	4
Max. Marks:75 (35TE + 15TI + 20PE + 5PI)	**Time: 2 H (Theory), 2h (Practical)**		

Part B- Contents of the Course

Instructions for Paper-Setter

Seven questions will be set in all. Question No.1 comprising objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking two questions from each section. The candidates will be required to attempt Q.No.1 & three others selecting one question from each section. Question 1 will be of 8 marks and remaining questions of 9 marks.

	CONTACT HOURS
Unit 1: Foundations of immunology: a) overview of immune system (definition; components; functions) b) Immune cells (white blood cells) and Lymphoid organs - Primary vs Secondary (location in body and their role) c) Types of Immune responses (innate vs adaptive immunity; passive vs active immunity)	**8**
Unit II: Antigen and Antibody a) Antigen (definition, examples, exogenous vs endogenous antigens and role) b) Antibodies (definition, general structure, functions, types, specificity) c) What happens when an antigen enters your body? Overview of antigen- antibody interactions and its importance d) Basic knowledge of blood group antigen, Rh factor and blood transfusion	**11**
Unit III: Clinical Immunology a) Immunodeficiency disorders (AIDS)	

b) Vaccines: Indian Immunization Schedule with brief description of all the vaccines. c) Principle and working of pregnancy test	**11**

List of Practical:

1. Determine ABO blood types.
2. Identify and count different types of white blood cells in a blood smear.
3. Demonstrate antigen-antibody interactions with agglutination reactions.
4. To identify and study the RBCs in a blood smear.
5. Demonstrate the working model of pregnancy test.

Part C-Learning Resources

Suggested readings:

1. Basic Immunology: Functions and Disorders of the Immune System [with Student Consult Online Access] Abul K. Abbas; Immunology Thomas J. Kindt
2. A textbook of immunology, Dr. P. Madhavee Latha, S. Chand publications.
3. Essential Immunology by Roitt, Wiley Blackwell publications.