D.K.M COLLEGE FOR WOMEN (AUTONOMOUS) VELLORE

DEPARTMENT OF BIOTECHNOLOGY

SYLLABUS FOR MASTER DEGREE COURSE IN BIOTECHNOLOGY

WITH EFFECT FROM 2024-2025

PG Department of Biotechnology with effect from 2024-2025

Choice Based Credit System (CBCS), Learning Outcomes Based Curriculum Framework (LOCF) PATTERN

The course of study and Scheme of Examination

S. No.	Part	Category	Ins. Hrs/ Week	Credit	Title of the paper	Maximum marks		
						CIA	Sem. Exam	Total
SEMESTER I								
1	Part I	Core Paper I	5	4	Biochemistry	25	75	100
2		Core Paper II	5	4	Molecular Genetics	25	75	100
3		Core Paper III	5	3	Molecular Cell Biology	25	75	100
4		Core practical - 1	5	3	(A) Biochemistry (B) Molecular Genetics (C)Molecular Cell biology	25	75	100
5		Elective -I	5	3	Bioinstrumentation	25	75	100
6		Elective-II	5	3	Enzymology	25	75	100
			30	**20**				**500**
SEMESTER II								
6	Part I	Core Paper IV	4	4	Microbiology	25	75	100
7		Core Paper V	4	4	Plant and Animal Biotechnology	25	75	100
8		Core Paper VI	4	3	Genetic Engineering	25	75	100
9		Core practical - 2	4	3	(A) Microbiology (B) Plant and Animal Biotechnology (C) Genetic Engineering	25	75	100
10		Elective-III	4	3	Regulatory affairs and Industrial standards (or) Pharmaceutical Biotechnology	25	75	100
11		Elective -IV	4	3	Environmental Biotechnology	25	75	100
12	Part II	Skill enhancement course-1	4	2	Tissue Engineering	25	75	100
13		Human Rights	2	2	Human Rights	25	75	100
14		MOOC Course	-	2	MOOC course	-	-	100
			30	**26**				**900**
SEMESTER III								
15	Part I	Core Paper VII	6	5	Bioinformatics	25	75	100
16		Core Paper VIII	6	5	Immunology	25	75	100
17		Core Paper IX	6	5	Bioprocess Technology	25	75	100
18		Core Paper-X Practical-3	6	4	Practical – III (A) Bioinformatics	25	75	100

					(B) Immunology (C)Bioprocess Technology			
19		Elective -V	3	3	Nano Biotechnology *(OR)* Molecular Developmental Biology	25	75	100
20	Part II	Skill enhancement course-2	3	2	Gene Manipulation Technology	25	75	100
21		Internship/Industrial Activity	0	2	Internship in Industries to Biotechnology Field (food / clinical trial/ dairy/ aqua sciences, pharmaceutical)CSIR/DBT/ DST research laboratories	-	-	100
			30	**26**				**700**
SEMESTER IV								
21	Part I	Core Paper XI	6	5	Research Methodology	25	75	100
22		Core Paper XII	6	5	Biostatistics	25	75	100
23		Project Work &Vive Voce	10	7	Dissertation	25	75	240
24		Elective – VI (Industry/Entrepreneurship) 20% Theory 80% Practical	4	3	Industrial Effluent Treatment / Biofertilizers and Organic Farming/ Bioentrepreneurship	25	75	100
25	Part II	Skill Enhancement Course-3	4	2	Stem Cell Biology (or) Bioethics, Human Rights and Social Issues	25	75	100
26	Part III	Extension Activity	-	1		-	-	-
			30	**23**				**640**
		Total	**120**	**95**				**2740**

Consolidated Table for Credit Distribution

	Category of Courses	**Credits for each courses**	**Number of Courses**	**Number of Credits in each Category of courses**	**Total Credits**	**Total Credits for the Programme**
Part I	Core Theory	5	5	25	82	92(CGPA)
		4	4	16		
		3	2	6		
	Core practical	4	1	4		
		3	2	6		
	Project with viva-voce	7	1	7		
	Elective	3	6	18		
Part II	Skill Enhancement	2	3	6	10	
	Human rights	2	1	2		
	MOOC course	2	1	2		
	Summer Internship	2	1	2	3	3(Non CGPA)
Part III	Extension activity	1	1	1		
						95

CHOICE BASED CREDIT SYSTEM AND LEARNING OUTCOMES BASED CURRICULUM, LEARNING OUTCOMES BASED CURRICULUM - FRAMEWORK FOR POSTGRADUATE EDUCATION	
Programme	**M.Sc. BIO-TECHNOLOGY**
Programme Code	
Duration	**PG – 2 YEARS**
Programme Outcomes (Pos)	**PO1: Problem Solving Skill** Apply knowledge of Management theories and Human Resource practices to solve business problems through research in Global context. **PO2: Decision Making Skill** Foster analytical and critical thinking abilities for data-based decision-making. **PO3: Ethical Value** Ability to incorporate quality, ethical and legal value-based perspectives to all organizational activities. **PO4: Communication Skill** Ability to develop communication, managerial and interpersonal skills. **PO5: Individual and Team Leadership Skill** Capability to lead themselves and the team to achieve organizational goals. **PO6: Employability Skill** Inculcate contemporary business practices to enhance employability skills in the competitive environment. **PO7: Entrepreneurial Skill** Equip with skills and competencies to become an entrepreneur. **PO8: Contribution to Society** Succeed in career endeavors and contribute significantly to society. **PO 9 Multicultural competence** Possess knowledge of the values and beliefs of multiple cultures and a global perspective. **PO 10: Moral and ethical awareness/reasoning** Ability to embrace moral/ethical values in conducting one's life.
Programme Specific Outcomes (PSOs)	**PSO1 – Placement** To prepare the students who will demonstrate respectful engagement with others' ideas, behaviors, beliefs and apply diverse frames of reference to decisions and actions. **PSO 2 - Entrepreneur** To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate startups and high potential organizations. **PSO3 – Research and Development** Design and implement HR systems and practices grounded in research that comply with employment laws, leading the organization towards growth and development. **PSO4 – Contribution to Business World** To produce employable, ethical and innovative professionals to sustain in the dynamic business world. **PSO 5 – Contribution to the Society** To contribute to the development of the society by collaborating with stakeholders for mutual benefit.

FIRST SEMESTER
Core Paper-I
BIOCHEMISTRY

Title of the paper	BIOCHEMISTRY	Subject code:	
Category of the course	Year	Semester	Credits
Core Paper	1st	1st	4

Learning Objectives:
The paper imparts a thorough knowledge on the basics of all the Biochemical concepts, Metabolic reactions and its regulation. The student will get to understand the core concepts of metabolism and physiological processes of the body in both healthy and disease state.

Course outcomes:
At the end of the Course, the Student will be able to:

CO-1	To understand the basics of pH and related principles and carbohydrate metabolism.
CO-2	To provide basic knowledge about lipid metabolism and related significance.
CO-3	To enlighten the students on Bio-energetics and Biological oxidation pathways.
CO-4	To update the knowledge on Amino acids and Protein.
CO-5	To assess and appraise the role of Nucleic acids.

SYLLABUS | Core paper|BIOCHEMISTRY				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	pH, pK . acid, base .Buffers- Henderson- Haselbalch equation, biological buffer system –Phosphate buffer system, protein buffer system, bicarbonate buffer system, amino acid buffer system and Hb buffer system. Water, Carbohydrates: Nomenclature, classification, structure, chemical and physical properties of carbohydrates. Metabolisms: glycogenesis, glycogenolysis, gluconeogenesis, pentose phosphate pathway	15	CO1	K1&K2
II	Lipids: Nomenclature, classification, structure, chemical and physical properties of fatty acids. Metabolisms: biosynthesis of fatty acids, triglycerols, phospholipids, glycolipids. Cholesterol biosynthesis, bile acids and salt formation. Eicosanoids, sphingolipids and steroid hormones.	15	CO2	K1,K2 & K3
III	Bioenergetics – Concept of energy, Principle of thermodynamics, Relationship between standard free energy and Equilibrium constant, ATP as universal unit of free energy in Biological systems. Biological oxidation: Electron transport chain, oxidative phosphorylation, glycolysis, citric acid cycle, cori's cycle, glyoxalate pathway. Oxidation of fatty acids- mitochondrial and peroxisomal ß-oxidation, alpha and beta oxidation, oxidation of unsaturated and odd chain fatty acids, ketone bodies.	15	CO3	K1,K2 & K3
IV	Amino acids and Protein: Nomenclature, Classification, structure, chemical and physical properties of amino acids and	15	CO4	K1,K2 & K3

	proteins. Metabolisms: Biosynthesis of amino acids. Degradation of proteins, nitrogen metabolism and carbon skeleton of amino acids. Over all inborn error metabolisms			
V	Nucleic acids: Nomenclature, Classification, structure, chemical and physical properties of purine and pyrimidines. de novo and salvage synthesis of purines, pyrimidine bases, nucleosides and nucleotides. Catabolisms of purines and pyrimidines bases. Synthetic analogues of nitrogenous bases	15	CO5	K1,K2 & K3

Reference books:

- Philip Kuchel, Simon Easterbrook-Smith, Vanessa Gysbers, Jacqui M. Matthews, 2011. Schaum.s Outline of Biochemistry, Third Edition (Schaum.s Outline Series), McGraw-Hill.
- Sathyanarayana.U and U.Chakrapani., 2011. Biochemistry. Books and Allied private limited, Kolkata.
- Jeremy M. Berg, John L. Tymoczko, Lubert Stryer, 2010. Biochemistry, Seventh Edition, W. H. Freeman.
- Albert Lehninger, David L. NelsonVoet Donald, Judith G.Voet and Charlotte W.Pratt., 2008. Principles of Biochemistry. John Wiley and sons, Inc., New Jersey.
- Michael M. Cox, 2008. Lehninger Principles of Biochemistry, Fifth Edition, W. H. Freeman publishers.

Useful web sites:

- mcdb-webarchive.mcdb.ucsb.edu/.../biochemistry/.../website-tourf.htm
- www.biochemweb.org/
- http://golgi.harvard.edu/biopages.html
- webarchive.mcdb.ucsb.edu/sears/biochemistry/info/website-

Core Paper –II
MOLECULAR GENETICS

Title of the paper	MOLECULAR GENETICS	Subject code:	
Category of the course	Year	Semester	Credits
Core Paper	1st	1st	4

Learning outcome:
The paper imparts a thorough knowledge on the basics of all the Genetics concepts, molecules and its regulation. The student will get to understand the core concepts of molecules and genetics.

Course outcomes:
At the end of the Course, the Student will be able to:

CO-1	To acquire good knowledge about the molecular mechanisms of gene expression and understand the theories behind the organization and functions of genetic material in the living world.
CO-2	Identify and distinguish genetic regulatory mechanisms at different levels and explain the processes behind mutations and other genetic changes and study various chromosomal abnormalities.
CO-3-	Make the students understand different range of DNA damage and range of their tools for their detection an.
CO-4	Learn the concepts of the transposons and their applications.
CO-5	Detects the Allele frequencies and genotype frequencies in populations and describe the concepts behind the theory of evolution

SYLLABUS | Core paper| MOLECULAR GENETICS				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	Genes and chromosomes, Colinearity of Genes and Proteins, Genetic code, Identification of DNA as the genetic material. The complexity of eukaryotic genome (introns, exons, repetitive DNA sequence, gene duplication and pseudogenes). DNA markers -VNTR, STR, microsatellite, SNP and their detection techniques	15	CO1	K1,K2 & K3
II	Replication of DNA, Gene expression and regulation in prokaryotes and eukaryotes. Mutation: Spontaneous and virus induced mutation, Radiation induced mutation. Ionizing radiation, UV radiation. Chromosomal Abnormalities and associated genetic diseases, Techniques in the study of chromosomes and their applications, Recombination – models	15	CO2	K1,K2 &K3
III	DNA Damage and Repair-Internal and external agents causing DNA damages. DNA damages (Oxidative damages, Depurinations, Depyrimidinations, O6-methylguanines, Cytosine deamination, single and double strand breaks). Mechanisms of DNA damage (transition, transversion, frameshift, nonsense mutations). Repair mechanisms (Photo reactivation, excision repair, mismatch repair, SOS repair). Insertion sequences in prokaryotes. Complex transposons (ex. Tn3, Tn5, Tn9 and Tn10). Mechanisms, control consequences and application of transposition by simple and complex	15	CO3	K1,K2 &K3

	elements			
IV	Allele frequencies and genotype frequency, Hardy-Weinberg principle, complications of dominance, special cases of random mating – multiple alleles, different frequencies between sexes (autosomal and X-linked) inbreeding, genetics and evolution, random genetic drift, Karyotyping and usefulness of chromosomes in understanding Genetic variation, gene linkage and chromosome mapping.	15	CO4	K1 &K2
V	Extrachromosomal heredity: Biology of Plasmids, their discovery, types and structure of F.RTH. *col* factors and Ti – Replication and partitioning, Incompatibility and copy number control-natural and artificial plasmid transfer and their applications- Human Genome Project, Genomics and Modern methodologies in understanding genome.	15	CO5	K1,K2 & K3

References:

- Principles of Genetics- 8th Edition, Gardner, Simmons and Snustad, 2002.
- The Cell- A Molecular Approach. 3rd Edition. Geoffrey M. Cooper, Robert E. Hausman, 2003.
- Genetics- Kavitha B. Ahluwalia, New Age International Pvt Ltd and Publishers, New Delhi, 2010
- Genetics – P.S Verma and A.K Agarwal (Rack 3, Central Library)
- Robert Brooker.2011. Genetics- Analysis and Principles. 4th edition. McGraw Hill.
- Leland Hartwell,Leroy Hood, Michael Goldberg, Ann Reynolds, Lee Silver,2010.Genetics: From Genes to Genomes, 4th Edition, McGraw Hill.
- Rastogi Smita and Neelam Pathak.,2010. Genetic Engineering, Oxford University Press, New Delhi. (Rack 3, Central Library)
- Watson, Hopkins, Roberts, Steitz, Weiner, 2004. Molecular Biology of Genes, 4th Edition.
- DNA markers Protocols, applications and overviews Anolles G. C. & Gresshoff P. M. Wiley-Liss
- Molecular markers in Plant Genetics and Biotechnology Vienne De. D. Science Publishers
- Genetics of Population Hedrick P.W. Jones & Bartlett 4 Principle of Population Genetics Hartl D. L. and Clark A. G. Sinauer Associates

Core Paper- III
MOLECULAR CELL BIOLOGY

Title of the paper	MOLECULAR CELL BIOLOGY		Subject code:
Category of the course	Year	Semester	Credits
Core Paper	1st	1st	3

Learning Outcome:
The paper imparts a thorough knowledge on the basics of all the Cell biology concepts, molecules and its regulation. The student will get to understand the core concepts of molecules and cell biology.

Course outcomes:

CO-1	To understanding of the molecular machinery of living cells and the principles that govern the structures of macromolecules and their participation in molecular recognition.
CO-2	Identify the structures and purposes of basic components in prokaryotic and eukaryotic cells and their molecular mechanism
CO-3	Demonstrate knowledge and understanding of the principles and basic mechanisms of nuclear envelope and its functions.
CO-4	Understand the metabolic pathways and the process of transmission of extracellular signals
CO-5	Demonstrate the operation of various microscopes and microtomy in the laboratory

SYLLABUS | Core paper| MOLECULAR CELL BIOLOGY				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	Introduction to cell Biology- Basic properties of cells-Cellular dimension-Size of cells and their composition-Cell origin and Evolution (Endosymbiotic theory).Organelles of the eukaryotic cell and its functions; Biomembranes - structural organization, transport across membrane (Passive, Active and Bulk transport); Cell-Cell adhesion- Cell junctions (Tight junctions, gap junctions, desmosomes, adherens); Extra cellular matrix (ECM)- components and role of ECM in growth	15	CO1	K1,K2 &K3
II	Structure of Nucleic acids, Genome organization in Eukaryotes, DNA Replication, Transcription, Translation and post translational Modification. Transport of secretary and membrane proteins across ER – post-translational modification in RER – transport to mitochondria, nucleus, chloroplast and peroxisome. Mechanism and regulation of vesicular transport – golgi and post-golgi sorting and processing – receptor mediated endocytosis.	15	CO2	K1,K2 &K3
III	Nucleus: Nuclear envelope – Nuclear pore complexes-nuclear matrix – organization of chromatin – supercoiling, linking number, twist - nucleosome and high order of folding and organization of chromosome(Solenoid and Zigzag model)-Global structure of chromosome –(Lamp brush and polytene	15	CO3	K1,K2 &K3

	chromosomes).			
IV	Molecular basis of eukaryotic cell cycle, Regulation and cell cycle check points; Programmed cell death (Apoptosis); Cell-Cell signaling-signaling molecules, types of signaling, signal transduction pathways (GPCR-cAMP, IP3, RTK, MAP Kinase, JAK-STAT, Wnt Pathway).	15	CO4	K1, K2 & K3
V	Cancer Biology: Multistage cancer development Mitogens, carcinogens, oncogenes and proto-oncogenes, tumor suppressor genes-Rb, p 53, Apoptosis and significance of apoptosis.	15	CO5	K1,K2 & K3

References

- Karp, G., 2009, Cell and Molecular Biology, Sixth edition, John Wiley & Sons, New York.
- David E.Sadva., 2009. Cell biology organelles structure and function, CBS publishers and distributors, New Delhi.
- Prakash S. Lohar , 2009. Cell and Molecular Biology.
- Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, 2007.,Molecular Biology of the Cell, Fifth edition. Garland Science.
- Lodish,H., Berk, A., Zipursky, S.L., Matsudaira, P., Kaiser, A., Krieger, Scott and Darnell, J. 2007. Molecular Cell Biology. Media Connected, sixth edition. W.H.Freeman and Company
- Geoffrey.M.Cooper, Robert.E.Hausman.2007.The Cell-A Molecular Approach, Fourth edition. Sinauer Associates. •
- Luiz Carlos Uchoa, Janqueira, Jose, Carneiro. 2005. Basic HistologyText and Atlas. McGraw-Hill Professional.
- Paul A, 2001, Text Book Of Cell And Molecular Biology 2edition Niyogi Books •
- T.Fleming. 2002. Cell interactions: A practical approach Second edition.
- Alberts B, Molecular Cell Biology. 8. Casimeris et al., Lewin's cells. Jones and Bartlett.
- Plopper, Principles of cell Biology. Jones and Bartlett.
- Gartner, Cell Biology and Histology. LWW.
- Pollard et al., Cell Biology. Sounders.
- Copper, The Cell a Molecular approach. Sinauer

Core practical-1
(Biochemistry, Molecular Genetics & Molecular Cell biology)

Title of the paper	PRACTICAL-1 (Biochemistry, Molecular Genetics & Molecular Cell biology)		Subject code:
Category of the course	Year	Semester	Credits
Core Practical	1st	1st	3

Learning Outcome:
The practical will establish a basic study skills on the subject and will improve the student's ability to calculate and improve their practical skill and knowledge.

Course outcomes:
On successful completion of the course the students will be able to

CO 1	(K2) Illustrate basic biochemistry procedures
CO 2	(K3) study the methods of estimation of biomolecules
CO 3	(K4) isolate & Analyze DNA, RNA & protein
CO 4	(K5) critically analyze the isolated biomolecules
CO 5	(K5) evaluate the quality and purity of DNA, RNA & Protein

SYLLABUS | PRACTICAL-1				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
A	**(A) Biochemistry – Practical** 1. Basic calculations in Biochemistry - Normality, Molarity, Molality percent solutions (v/v, w/v). 2. Calibration of pH meter 3. Preparation of biological buffer - phosphate buffer 4. Estimation of Proteins by Lowry's method/Biuret method/Bradford method 5. Estimation of RNA by orcinol method 6. Estimation of DNA by diphenylamine method 7. Estimation of Carbohydrate by Anthrone method 8. Separation of amino acids by Paper Chromatography 9. Separation of sugars by Paper Chromatography 10. Separation of amino acids by Thin layer chromatography 11. Separation of sugars by Thin layer chromatography **Demo Experiments** 1. Gel permeation chromatography, 2. Ion exchange chromatography	25	CO1 CO2 CO3 CO4 CO5	K3 & K4
B	**(B) Molecular Genetics - Practical** 1. Isolation of DNA from bacteria 2. Isolation of DNA from plants 3. Isolation of DNA from animal tissue 4. Isolation of DNA from blood 5. Plasmid DNA isolation.	25	CO1 CO2 CO3 CO4 CO5	K3,K4 &K5

	6. Agarose gel electrophoresis of DNA 7. Isolation of RNA 8. Radiation induced genetic damage assessment 9. Chemical induced genetic damage assessment.			
C	**(C) Molecular Cell Biology -Practical** 1. Introduction to Microtome and types 2. Microtomy-Fixation of tissue 3. Microtomy -Embedding 4. Microtomy-Sectioning of tissue 5. H&E Staining of tissues 6. Histochemical staining to localize proteins 7. Histochemical staining to localize carbohydrates 8. Histochemical staining to localize lipids. 9. Subcellular fractionation and marker enzyme detection (mitochondria). 10. Giant chromosome studies in Chironomous larvae 11. Meiotic study in flower bud or cockroach or grasshopper	25	CO1 CO2 CO3 CO4 CO5	K3,K4 & K5

Elective –I
BIOINSTRUMENTATION

Title of the paper	BIOINSTRUMENTATION	Subject code:	
Category of the course	Year	Semester	Credits
Elective Paper	1st	1st	3

Learning Outcome:
The paper imparts a thorough knowledge on the basics of all the instrumentation concepts, in biology. The student will get to understand the core concepts of biological instruments and their principles.

Course outcomes:
At the end of the Course, the Student will be able to:

CO-1	Introduction and various types of Microscopic techniques
CO-2	Impart understanding on centrifugation instruments and techniques
CO-3-	Separation of Biomolecules
CO-4	Analytical methods on Spectroscopic Analysis
CO-5	Understand the application and Detection on Bioinstrumentation

SYLLABUS | Elective Paper| BIOINSTRUMENTATION				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	Microscopic Techniques: Principles and Applications: Compound, Light, Phase Contrast, Fluorescent Microscopy, Scanning and Transmission Electron Microscopy, Atomic Force Microscopy, Confocal Microscopy, FRET and Flow Cytometry.	15	CO1	K1 & K2
II	Centrifugation: Principle and Applications of various types of centrifugation, Sedimentation Coefficient, Svedberg unit, RCF, Density Gradient Centrifugation. Chromatography Techniques: Principle and Application of Paper Chromatography, TLC, Gel Filtration Chromatography, Ion Exchange Chromatography, Affinity Chromatography, GC & HPLC.	15	CO2	K1, K2,K3
III	Electrophoretic Techniques: Principle and Application of Agarose Gel Electrophoresis, 2D-gel Electrophoresis, PAGE-NATIVE & SDS PAGE, Iso-electric Focusing, Immuno Electrophoresis, ELISA, RIA, Southern, Northern and Western Blotting, PCR and RT-PCR, Microarray (DNA, Proteins)	15	CO3	K1, K2 & K3
IV	Spectroscopic Techniques: Theory and Application of UV and Visible Spectroscopy, Fluorescence Spectroscopy, Mass Spectroscopy, IR Spectroscopy NMR, ESR, Atomic Absorption Spectroscopy and Raman Spectroscopy	15	CO4	K1,K2 & K3
V	Radio-isotopic Techniques: Introduction to Radioisotopes, Uses and their Biological Applications, Radioactive Decay – Types and Measurement, Principles and Applications of GM Counter, Liquid Scintillation Counter, Autoradiography, Radiation Dosimetry, Health effects of Radiations.	15	CO5	K1,K2 & K3
Reference books				

- M.H. Fulekar and Bhawana Pandey Bioinstrumentation, Wiley
- Keith Wilson, John Walker, 2010. Principles and Techniques of Biochemistry and Molecular Biology (7th Edition), Cambridge University Press •
- David L. Nelson, Michael M. Cox. Menninger (2008). Principles of Biochemistry, Fifth edition W. H. Freeman, New York. •
- Experiments in Biochemistry: A Hands-On Approach by Shawn O. Farrell, Ryan T. Ranallo, Paperback: 324 pages, Publisher: Brooks Cole. 20 •
- Metzler D.E. 2001, the chemical reactions of living cells –Academic Press. 2nd edition.
- Stryer L,1999, Biochemistry-W.H. Freeman & Company, New York. 1. • 4th edition
- L.Veerakumari (2006) Bioinstrumentation MJP Publisher Kindle edition
- Jefrey. M., Backer el al., 1996. Biotechnology- A Laboratory Course. Academic Press, New York.
- Holcapek, M., Byrdwell, Wm. C. 2017. Handbook of Advanced Chromatography /Mass Spectrometry Techniques, Elsevier

Elective –II
ENZYMOLOGY

Title of the paper	ENZYMOLOGY		Subject code:
Category of the course	Year	Semester	Credits
Elective Paper	1st	1st	3

Learning Outcome:
The subject imparts knowledge on the fundamentals of enzyme structure and its kinetics. The student will be provided with a basic knowledge and understanding about the functions of enzyme as well as the industrial application of enzymes.

Course outcomes:

CO-1	(K2) Explain the basics of enzyme nomenclature and properties
CO-2	(K3) Classify and Cognize the native and immobilized enzyme
CO-3	(K4) Examine the equations of steady state kinetics
CO-4	(K5) Assess extraction and downstream processing of enzymes
CO-5	(K6) Compile the uses of enzymes and design enzymes for Industrial and Clinical application

SYLLABUS | Elective Paper| ENZYMOLOGY				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	Introduction to enzymes, Classification, nomenclature and general properties like effects of pH, substrate and temperature on enzyme catalysed reactions. Extraction Isolation and purification of enzymes by precipitation, centrifugation, chromatography and electrophoresis and liquid-liquid extraction methods	15	CO1 CO5	K3 & K5
II	Kinetics of catalysed reaction : Single substrate reactions, bisubstrate reactions, concept of Michaelis - Menten, Briggs Haldane relationship, Determination and significance of kinetic constants, Limitations of Michaelis-Menten Kinetics, line weaver burk plot, Inhibition of enzyme activity	15	CO1 CO2 CO5	K3 & K5
III	Enzyme catalysis: enzyme specificity and the concept of active site, determination of active site. Stereospecificity of enzymes. Mechanism of catalysis: Proximity and orientation effects, general acid-base catalysis, nucleophilic and electrophilic attacks, catalysis by distortion, metal ion catalysis	15	CO1 CO3	K3 & K4
IV	Theories on mechanism of catalysis.-Mechanism of enzymes action: mechanism of action of lysozyme, and DNA polymerase. Multienzymes system, Mechanism of action and regulation of pyruvate dehydrogenase and fatty acid synthetase complex	15	CO1 CO4	K3, K4 & K6
V	Coenzyme action. Enzyme regulation: General mechanisms of enzyme regulation, Allosteric enzymes, Symmetric and sequential modes for action of allosteric enzymes. Reversible and	15	CO1 CO5	K3,K4, K5 & K6

	irreversible covalent modification of enzymes, Immobilized enzymes and their industrial applications.Clinical and industrial applications of enzymes, Enzyme Engineering			

Reference Books

- Nicholas C.Price and Lewis Stevens., 2010. Fundamentals of Enzymology. Oxford University Press, New Delhi
- Lehninger, Nelson and Cox, 2005, Principles of Biochemistry - 4th edition, WH Freeman and Company, New York, USA
- Principles of Biochemistry with human focus - Garrett and Grisham, 2002, Harcourt College Publishers, Orlando, Florida, USA.
- Geoffrey L, Zubay, Biochemistry -, 1998, 4th edition. 23
- Donald Voet, Judith Voet and Pratt, 1995, Fundamentals of Biochemistry, 2nd edition.
- Harper.s Biochemistry - Murray et al, 2000, 25th edition, Appleton and Lange Publishers.
- Enzymes – Trevor Palmer 2002.

Useful Websites

- www.lsbu.ac.uk/biology/enztech/
- www. lsbu.ac.uk/biology/enzyme/

http://www.aetlted.com/tech/applications.html

SECOND SEMESTER
Core Paper-IV
MICROBIOLOGY

Title of the paper	MICROBIOLOGY	Subject code:	
Category of the course	Year	Semester	Credits
Core Paper	1st	2nd	4

Learning Outcome:
To provide a comprehensive knowledge on taxonomy and microbial diversity, growth, their harmful effects and beneficial role of microorganisms in agriculture and environment

Course outcomes:

CO-1	To understand the major discoveries of microbiology and describe microbial diversity, Microbial growth and metabolism.
CO-2	To provide basic knowledge about microbial culture, identification of microbes, principle and working of microscopes and sterilization techniques
CO-3	To enlighten the students on host microbe interaction and Epidemiology of microbial disease
CO-4	To update the knowledge on epidemic and pandemic diseases.
CO-5	To assess and appraise the role of novel microbes in environment and integrate them in specific innovative approaches.

SYLLABUS | Core Paper | MICROBIOLOGY				
Unit	**Content**	**Hours**	**Cos**	**Cognitive level**
I	History and microbial taxonomy: Major discoveries related to the field of microbiology: Antony Von Leeuwenhoek, Louis Pasteur, Robert Koch and Edward Jenner. Microbial taxonomy: Bacteria, viruses, fungi, algae and protozoa, Microbial diversity: Biovars, Serovars and Prions, Microbial growth and metabolism: Microbial growth: Growth curve, factors affecting growth, Microbial metabolism- Methanogenesis, acetogenesis and auxotrophs	15	CO1 CO2	K1,K2 &K3
II	Microbial culture, identification, and control: Nutritional requirements for growth - Growth media and types, Pure culture techniques: Serial dilution and plating methods, Staining methods - Principles and types of staining (simple and differential), Identification of bacteria – Biochemical, 16s rRNA sequencing. Microbial growth control: Physical Methods – Heat, Filtration, Low Temperatures, High Pressure, Desiccation, Osmotic Pressure, Radiation; Chemical Methods	15	CO2 CO3 CO5	K2,K3,K5
III	Host microbe interaction and Epidemiology: Human microbiome; Skin, Gastrointestinal tract, Oral cavity, Lung. Symbiotic relationship of microbes: Symbiosis, Mutualism, Parasitism, Commensalism and endophyte. Epidemiology of microbes: causes, types and transmission of epidemic, endemic and pandemic diseases	10	CO1 CO3 CO4	K1,K2,K3

IV	Microbial Diseases: Microbial diseases - General characteristics, pathogenesis, laboratory diagnosis and control measures of Pandemic and Epidemic diseases: Tuberculosis, Leprosy, Cholera, Typhoid, COVID-19, Flu, AIDS, Ebola, Zika Virus, Small Pox, Dengue, Chickungunya, Malaria,	10	CO4 CO5	K4 &K5
V	Agricultural and Environmental Microbiology: Biological nitrogen fixation, free living, symbiotic nitrogen fixation mechanism, Biofertilizers- types and applications; Rhizosphere effect. Biogeochemical cycles-Carbon, Nitrogen; Methanogenic bacteria Extremphiles- Thermophiles Acidophiles, Halophiles and alkalophiles; Biotechnological application of extremophiles	10	CO1 CO2 CO3	K4 & K5

References

- Joanne Willey, Linda Sherwood, Christopher J. Woolverton, (2017). Prescott's Microbiology, (10th edition), McGraw-Hill Education, ISBN: 978-1259281594.
- Maheshwari D K, Dubey R C 2013. A Textbook of Microbiology.4th Edn S Chand Publishing India.
- Ananthanarayan and Paniker's (2017) Textbook of Microbiology, (10th edition), The Orient Blackswan, ISBN: 978-9386235251.
- Benson HJ. (1999). Microbiological Applications: A Laboratory manual in General Microbiology, 7th Edition, McGraw Hill. 5
- Managing epidemics- Key facts about major deadly diseases, World Health Organization (WHO) 2018. 9. O'Flaherty, Vincent & Collins, Gavin & Mahony, Thérèse. (2010). Environmental Microbiology, Second Edition. 10.1002/9780470495117.ch11.
- Agriculture Microbiology, 2016. E-Course Developed By TNAU (ICAR)

Web Sources

- https://www.who.int/emergencies/diseases/managing-epidemics-interactive.pdf ISBN 978-92-4-156553-0. https://doi.org/10.3389/fmicb.2020.631736
- https://www.agrimoon.com/wp-content/uploads/AGRICULTURAL-Microbiology.pdf.

Core Paper-V
PLANT AND ANIMAL BIOTECHNOLOGY

Title of the paper	PLANT AND ANIMAL BIOTECHNOLOGY	Subject code:	
Category of the course	Year	Semester	Credits
Core Paper	1st	2nd	4

Learning Outcome:
The paper imparts a thorough knowledge on the basics of all the biotechnological application on plant and animals. The student will get to understand the core concepts of biotechnology.

Course outcomes:

CO-1	To impart theoretical knowledge on various techniques of plant biotechnology like tissue culture, plant genetic transformation and their application in industries.
CO-2	Importance of secondary metabolites and production in plants.
CO-3	To develop concepts, principles and processes in animal biotechnology.
CO-4	Concept and different types in Animal Cell Culture and animal cell lines.
CO-5	Use of molecular biology techniques genetically engineer the animals to improve sustainability, productivity and suitability for pharmaceutical and industrial applications.

SYLLABUS | Core Paper | PLANT AND ANIMAL BIOTECHNOLOGY				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	Introduction of plant tissue culture, composition of media, Micropropagation, organogenesis, somatic embryogenesis, haploid production, protoplast isolation and fusion, hybrid and cybrid, synthetic seed production. Secondary metabolites in plants - Phytochemicals- Glycosides and Flavonoids; Anthocyanins and Coumarins - Lignans, Terpenes, Volatile oils and Saponins; Carotenoids and Alkaloids: biogenesis, therapeutic applications	15	CO1 CO5	K1,K2 &K3
II	Plant Transformation: Direct transformation by electroporation and particle gun bombardment. Agrobacterium, Ti plasmid vector. Theory and techniques for the development of new genetic traits, conferring resistance to biotic and abiotic. Plant engineering towards the development of enriched food products, plant growth regulators; Molecular Marker aided breeding: RFLP maps	15	CO1 CO2 CO5	K1,K2 & K5
III	Animal health disease diagnosis, hybridoma technique, monoclonal antibodies, application of probes for disease diagnosis of existing and emerging animal diseases. Oral vaccines, DNA Vaccines in animal disease. Cell culture: primary and established culture; organ culture; tissue culture	10	CO1 CO3 CO5	K4 & K5
IV	Disaggregation of tissue and primary culture; cell separation, cell synchronization, cryo preservation. Scaling up of animal cell culture, cell line and cloning micromanipulation and cloning. Measuring parameters for growth, measurement of	10	CO4 CO5	K2,K3,K4 & K5

	cell death, apoptosis and its determination, cytotoxicity assays.			
V	Application of animal cell culture: in vitro testing of drugs, production of human and animal viral vaccines and pharmaceutical proteins. Transgenic animals: Production and application; transgenic animals in livestock improvement, transgenic animals as model for human diseases; Stem Cells- Properties, Types, Therapy, Prospects and Ethics in stem cell research.	10	CO5	K3,K4 & K6

Reference Books

- Razdan. M. K., 2011. Plant tissue culture. Oxford and IBH publishing Company Pvt. Ltd, New Delhi.
- Chawla. H. S., 2010. Introduction to plant biotechnology. Oxford and IBH publishing company pvt. Ltd, New delhi.
- Ian Freshney, 2010. Culture of animal cells. 6th edition, Wiley-Blackwell publishers.
- Slater, 2008. Plant Biotechnology: The Genetic manipulation of plants, Second Edition, Oxford University Press, USA.
- J.D.Watson, Gillman, J.Witknowski and M.Zoller, 2006. Recombinant DNA. 3rd ed.
- W.H.Freeman. 26 K. Dass. 2005, Text book of Biotechnology, Second Edition, Wiley Dreamtech, India (P) Ltd.
- H.Kreuzer & A.Massey. 2001. Recombinant DNA and Biotechnology: A guide for teachers Second Edition. ASM press, Washington.
- M.Sudhir. 2000. Applied Biotechnology & Plant Genetics. Dominant publishers & Distributors.
- Genetic Engineering of Animals by (Ed) A.Puhler, VCH Publishers, Weinheim, FRG, 1993.
- Animal Cell culture Practical approach. Ed. John R.W.Masters, Oxford.2004.
- Concepts in Biotechnology D. Balasubramaniam, Bryce, Dharmalingam, Green, Jayaraman Univ. Press, 1996

Core Paper-VI
GENETIC ENGINEERING

Title of the paper	GENETIC ENGINEERING	Subject code:	
Category of the course	Year	Semester	Credits
Core Paper	1st	2nd	3

Learning Outcome:
The paper imparts a thorough knowledge on the basics of all the biotechnological application on plant and animals. The student will get to understand the core concepts of biotechnology.

Course outcomes:

CO-1	Understanding the basic steps of gene cloning and the role of enzymes and vectors responsible for gene manipulation, transformation and genetic engineering.
CO-2	Getting detailed knowledge of gene transfer methods and identifying suitable hosts for cloning.
CO-3	Acquiring theoretical knowledge in the techniques, tools, and application and safety measures of genetic engineering.
CO-4	Describes the genome mapping and sequencing and methods for gene therapy.
CO-5	Elucidate different techniques involved in genetic engineering

SYLLABUS | Core Paper| GENETIC ENGINEERING				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	Gene cloning. Genetic engineering tools. Nucleic acid manipulating enzymes. Promoters, Selectable markers and reporters used in rDNA technology. Restriction digestion, Ligation, Transformation, Selection of Recombinants. Construction of gene libraries	10	CO1	K1,K2, K5
II	E.Coli vectors - pBR322 and its derivatives; Cloning vectors for gram negative bacteria - ColE1, p15A, R1, IncPa, pSC101; Lambda bacteriophage vectors, filamentous phages, Cosmids, Phasmids, Phagemids. Cloning in gram-positive bacteria (Bacillus subtilis)	10	CO2	K2,K3, K4
III	Cloning in yeast *Saccharomyces cerevisae*. Life cycle and types of vectors; Eukaryotic vectors. SV40 (molecular genetics and expression); Specialized cloning vector for cDNA; Synthesis of specific RNA in vitro; Vectors for cloning promoters and terminators; vectors with adjustable copy number	10	CO4	K3,K4 &K6
IV	Nucleic acid hybridization techniques; Molecular probes (Types of probes and its construction); probe labeling. Nick translation, End labeling and Random primer labeling. Polymerase chain reaction and its variants; DNA fingerprinting; DNA sequencing first generation sequencing methods (Maxam and Gilbert sequencing, Sangers Dideoxy sequencing, Pyrosequencing, PCR based sequencing and	15	CO4	K3,K4,K5 & K6

	hybridization sequencing).Second generation sequencing methods			
V	Site directed mutagenesis; chromosome walking and jumping. Molecular techniques in prenatal diagnosis gene therapy, knockout mice and Flavr savr tomato, Pharmaceutical products (Vaccine etc), Crop improvement. Pesticide resistance, herbicide resistance, transgenic animals and GM foods.	15	CO5	K3,K4,K5 & K6

Reference Books:

- T.A. Brown, 2010. Gene cloning and DNA analysis: An introduction, 6th edition, Wiley-Blackwell.
- Sandy B.Primrose and Richard Twyman, 2006. Principles of Gene Manipulation and genomics, 7th edition, Wiley-Blackwell.
- Lewin, 2009. Genes X, 10th edition, Jones & Barlett Publishers
- Raymond Rodriguez and David T.Denhart 2003.Vectors, A survey of molecular cloning vectors and their uses
- Errst-L. Winnacker 1987.From genes to clones. Introduction to Gene Technology,
- Ed. David V. Geoddel 2002.Gene Expression technologies. Methods in enzymology (Vol.185)
- William Wu, Michael J.Welsh, Peter B.Kaufrmar, Helen H.Zhang 2001. Methods in Gene Biotechnology

PRACTICAL-2

(Microbiology, Plant and Animal Biotechnology & Genetic Engineering)

Title of the paper	PRACTICAL-II (Microbiology, Plant and Animal Biotechnology & Genetic Engineering)	Subject code:	
Category of the course	Year	Semester	Credits
Core Paper	1st	2nd	3

Learning Outcome:

The practical will establish a basic study skill on the subject and will improve the student's ability to have a hands on experience on the above core subjects.

Course outcomes:

CO-1	(K2) Isolate and identify microbes from various sources.
CO-2	(K3) Characterize microbes.
CO-3	(K4) Examine Plant and Animal cells and their functions
CO-4	(K5) Assess extracted DNA, RNA and protein for rDNA technology
CO-5	(K6) to study cloning tools

SYLLABUS | Core Paper| PRACTICAL-2				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
A	**(A) Microbiology-Practical** 1. Isolation and Enumeration of bacteria from soil 2. Isolation and Enumeration of bacteria from water 3. Isolation and Enumeration of bacteria from air 4. Isolation and Enumeration of bacteria from plant surface. 5. Isolation of bacteria from root nodules, 6. Isolation of pure culture of *Aspergillus niger*, 7. Isolation of pure culture of *Streptomyces.* 8. Gram staining and morphological characterization of microbes. 9. Determination of growth curve of bacteria – *E.coli* 10. Biochemical characterization - catalase, oxidase, urease, coagulase, 11. Starch Hydrolysis test 12. Lipid Hydrolysis test 13. Test for H_2S production or TSI agar test 14. Antibiotic sensitivity test **Demonstration** 16s rRNA sequencing	20	CO1 CO2 CO3 CO4 CO5	K,.K2, K3, K4, K5 & K6
B	**(B) Plant and Animal Biotechnology - Practical:** 1. Preparation of MS medium stock solution –Macro salt, Micro salt, Vitamin, growth regulator 2. Surface sterilization of various explants – leaf, shoot, root, and seed. 3. Generation of Callus from any two explants (leaf, root, bud and shoot apex)	20	CO1 CO2 CO3 CO4 CO5	K3,K4 & K5

	4. Maintenance of callus culture. 5. Anther culture 6. Pollen culture 7. Isolation of plant protoplast 8. Protoplast viability test. 9. Localization of nucleus using nuclear stain. 10. Introduction to Animal Cell culture: Procedure for handling cells and medium. 11. Cleaning and sterilization of glassware and plastic tissue culture flasks 12. Preparation of tissue culture media 13. Trypsinization of established cell culture. 14. Cell counting and viability - staining of cells (a) Vital Staining (Trypan blue) Isolation and Culture Of Splenocytes			
C	**(C) Genetic Engineering - Practical** 1. Preparation of plasmid DNA by alkaline lysis method. 2. Agarose gel electrophoresis 3. Methylene blue DNA staining 4. Elution of DNA from agarose gel. 5. Restriction enzyme digestion. 6. Ligation. 7. Competent cell preparation 8. RAPD (Demo) 9. RFLP (Demo) 10. Amplification of DNA - PCR 11. Determination of molecular weight of DNA **Demonstration:** RT-PCR for COVID-19	20	CO1 CO2 CO3 CO4 CO5	K3,K4 &K5

Elective Paper-III
REGULATORY AFFAIRS AND INDUSTRIAL STANDARDS

Title of the paper	REGULATORY AFFAIRS AND INDUSTRIAL STANDARDS	Subject code:	
Category of the course	Year	Semester	Credits
Elective Paper	1st	2nd	3

Learning Outcome:
The subject imparts knowledge on the fundamentals of regulatory requirement in industries. The student will be provided with a basic knowledge and understanding about the regulatory affairs based on biotechnological industry requirements.

Course outcomes:

CO-1	Elucidate the basic requirements of establish laboratory for testing samples as per the regulatory body's requirements
CO-2	Describe the Scientific, technical knowledge about various food preservation techniques
CO-3	Describe the basic concepts of packing of food materials, various parameters observed during packaging
CO-4	Describe the testing of food materials and identifying of microbial food contaminant
CO-5	Explain the basic of food safety management system, good manufacturing practice and good hygienic practices

SYLLABUS | Elective Paper | REGULATORY AFFAIRS AND INDUSTRIAL STANDARDS				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	**Planning, Organisation and setting of Food testing laboratory and laboratory safety** Understand the requirements for setting up a laboratory for the legal defensibility of analytical data. The ideal structure design, environment, layout for microbiological testing and Air handling etc., Introduction about accreditation, Different accreditation bodies (NABL, APLAC, ILAC), Requirements for ISO/IEC 17025:2017, documentation, Laboratory safety: Personnel and laboratory hygiene, emergency planning, general hazards in a food laboratory, safety equipment, storage of chemicals, acids, flammables etc, handling and biological spills and waste disposal.	10	CO1	K2,K3,K4
II	**Principles of Food Preservation technology** Heat: Principles of Heat transfer, Blanching, Pasteurization, Heat sterilization, thermal extrusion, cooking. Water Removal: Forms of Water in Foods, Sorption of water in foods, Water activity, drying and evaporation technology. Temperature reduction: Chilling, Freezing, Radiation: Ionizing Radiation, Microwave, Use of chemicals: Class-I & Class-II preservatives, smoke other chemical additives, New non-thermal methods: High hydrostatic pressure, modified atmosphere.	15	CO2	K2 & K3
III	**Principles of Food Packaging technology**	15	CO3	K2,K3 &

	Different packaging materials used for food packaging and their properties: Glass, metals, paper, plastics, biodegradable and edible films and coatings aseptic packaging and combinations, Selection of packaging material and design for various food commodities including fresh produce (Fruits and vegetables), milk and milk products (dairy), cereal, pulses, oil, meat, fish, poultry, water and processed foods, Evaluation of quality and safety of packaging materials- different testing procedures, Function of packaging-Protective packaging and active packaging, CAP/MAP packaging aseptic processing and packaging, irradiated packaging, retort pouch and microwaveable packaging.			K4
IV	**Food Microbiology and testing** Sources of microorganisms in food chain (raw materials, water, air, equipment etc) and microbiological quality of foods, Microbial growth characteristics. Microbial growth in foods: intrinsic (pH, Moisture content, oxidation-reduction potential, nutrient content, antimicrobial constituents and extrinsic parameters (temperature of storage, relative humidity of environment, presence and concentration of gases in the environment, Thermal destruction of microorganisms: Thermal death time, Microbial food spoilage and food borne diseases, food pathogens, *Bacillus cereus* and other *Bacillus* species, *Campylobacter*, *Clostridium* species, *Enterobacteriaceae, E. coli, Listeria monocytogens, Salmonella, Shigella, Staphylococcus aureus, Vibrio* species, *Yersinia enterocolitica,* fungi, virus etc., Methods for the Microbiological examination of foods: Sampling activity and sampling plan, pure culture isolation: streaking, serial dilution and plating, cultivation, maintenance and preservation/stocking of pure culture, Observation of Indicator organisms: Direct examination, enumeration methods, plate count, MPN, biochemical test, Rapid methods detection of specific organisms.	10	CO4	K2,K3,K4
V	**HACCP and Food safety management systems:** ISO 22000: Importance of implementing a HACCP system and how it can be applied to various products. Prerequisite programs, HACCP principles, some limitation of HACCP food safety objective (FSO). Food safety audits: Management review, audit certification and importance. Good manufacturing practices (GMP), Good hygienic practices (GHP), Food safety plan, food safety management risk analysis. Traceability food products recall and sanitation.	10	CO5	K2,K3 & K6

References:

- ISO 9001, Quality management systems – Requirements
- ISO 17034 General requirements for the competence of reference material producers
- ISO/IEC 17043 Conformity assessment – General requirements for proficiency testing.
- Food safety standards authority regulation 2011.

Elective Paper-III
PHARMACEUTICAL BIOTECHNOLOGY

Title of the paper	PHARMACEUTICAL BIOTECHNOLOGY	Subject code:	
Category of the course	Year	Semester	Credits
Elective Paper	1st	2nd	3

Learning Outcome:
The subject imparts knowledge on the fundamentals of pharmaceutical biotechnology. The student will be provided with a basic knowledge and understanding about the pharmaceutical products produced based on biotechnological methods and its biomedical applications.

Course outcomes:

CO-1	Explain the basic components of pharmaceutical and biotechnology industry and methods and applications of biosensor
CO-2	Describe the Scientific, technical and economic aspects of vaccine & rDNA technology
CO-3	Describe the basic concepts of protein Engineering, therapeutic proteins and enzyme immobilization techniques
CO-4	Describe the concepts of hybridoma technology, microbial biotransformation and microbial bio-transformed products
CO-5	Explain the basic components of somatic gene therapy, Xeno-transplantation and fermenter and bio safety methods

SYLLABUS | Elective Paper | PHARMACEUTICAL BIOTECHNOLOGY				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	Introduction to concepts and technologies in pharmaceutical biotechnology and industrial applications, Biosensors- Working and applications of biosensors in pharmaceutical Industries; Pharmacology and Ethnopharmacology: Scope, applications and Importance.	10	CO1	K1
II	Scientific, technical and economic aspects of vaccine research and development, Preparation of bacterial vaccines, toxoids, viral vaccine and antitoxins, Storage conditions and stability of vaccines, Application of rDNA technology and genetic engineering in the production of: (i) Interferon (ii) Vaccines - hepatitis- B (iii) Hormones – Insulin, Brief introduction to Protein Engineering.	15	CO2	K3 & K4
III	Hybridoma technology - Production, Purification and Applications, Formulation of biotech products - Rituximab, Introduction to Microbial biotransformation and applications, Study of the production of – penicillins, citric acid, Vitamin B12, Glutamic acid, Xenotransplantation in pharmaceutical biotechnology, Large scale production fermenter design and its various controls, Bio safety in pharmaceutical industry	15	CO3	K2

IV	Pharmacological activity of Plant drugs, Plant Chemicals in modern pharmacology; biochemistry and pharmacology of atropine, caffeine, ephedrine, opioids, synthetic substitutes for therapeutically active plant constituents; drug improvement by structure modification and bio-transformation. Criteria for pharmacological evaluation of drugs.	10	CO4	K2 & K4
V	Clinical Pharmacology, Drug therapy, Mechanism of drug action, Therapeutic efficacy, Therapeutic index, tolerance, dosage forms and routes of drug action , factors affecting drug action; Adverse Drug reactions and drug poisoning-classification and causes of ADR; principle clinical manifestations and treatment of ADR, General principles of management of drug poisoning; antidotes, classification of drugs.	10	CO5	K1,K2 &K5

Reference Books:

- Harbans lal, 2011. Pharmaceuticals biochemistry. CBS Publishers and distributors Pvt. Ltd, Chennai.
- Carlos A. Guzmán and Giora Z. Feuerstein, 2009. Pharmaceutical Biotechnology, 1st edition, Springer.
- Daniel Figeys (Ed.). 2005. Industrial Proteomics: Applications for Biotechnology and Pharmaceuticals. Wiley, John & Sons, Incorporated.
- Kayser, O and Muller R.H.. 2004. Pharmaceutical Biotechnology Drug Discovery and Clinical Applications. WILEY-VCH
- Leon Shargel, Andrew B. C. Yu, Susanna Wu-Pong, and Yu Andrew B. C. 2004. Applied Biopharmaceutics & Pharmacokinetics. McGraw-Hill Companies
- Stefania Spada, Garywalsh. 2004. Directory of approved biopharmaceutical
- Gary Walsh. 2003. Biopharmaceutical, Biochemistry & Biotechnology.
- Heinrich Klefenz. 2002. Industrial pharmaceutical biotechnology.
- Thomas Lengauer (Ed.). 2002. Bioinformatics – from Genomes to Drugs. Volume I& II. Wiley-VCH.
- John F. Corpenter (editor), Mark C. Manning. 2002. Rational Design of stable formulation Theory and Practice (Pharmaceutical Biotechnology). Plenum, US. Ist edition.
- D.I.A. Crommelin, et al., 2002. Pharmaceutical Biology. Amazon prime publications.
- Werner Kalow, Urs A Meyer and Rachel F. Tyndale. 2001.
- Pharmacogenomics. CPL press.

Useful Websites:

- https://tugasakhirsttifbogor.files.wordpress.com/2018/08/pharmaceutical-biotechnology.pdf
- http://library.nuft.edu.ua/ebook/file/Gad2007.pdf
- https://oasis.iik.ac.id:9443/library/repository/a932eb462c49885a2c72755977036b81.pdf

Elective Paper-IV
ENVIRONMENTAL BIOTECHNOLOGY

Title of the paper	ENVIRONMENTAL BIOTECHNOLOGY	Subject code:	
Category of the course	Year	Semester	Credits
Elective Paper	1st	2nd	3

Learning Outcome:
The subject imparts knowledge on the fundamentals of ecology and pollution. The student will be provided with a basic knowledge and understanding about the functions of ecosystem and reduction of pollution by biotechnological tools.

Course outcomes:
On successful completion of the course the students will be able to

CO-1	(K2) explain various waste management methods
CO-2	(K3) classify potential methods of biodegrading organic pollutants.
CO-3	(K4) examine the techniques involved in remediation of polluted environments
CO-4	(K5) assess types of pollution & its control
CO-5	(K6) compile biotechnological approaches to degrade xenobiotic compounds

SYLLABUS | Elective Paper| ENVIRONMENTAL BIOTECHNOLOGY				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	Environment: Basic concepts and issues; Environmental Pollution: Types of pollution & its control strategies -Air pollution, Soil pollution, Water pollution, Oil pollution & Radioactive pollution. Environmental management and Conservation, Environmental Laws & Agencies involved in conservation.	10	CO1 CO5	K2
II	Biofilm Kinetics: Completely mixed biofilm reactor-Soluble microbial products and inert biomass-Special-case biofilm solution. Reactor types:- batch reactor - continuous-flow stirred-tank reactor- Plug-flow reactor. Engineering design of reactors- Reactors in series	15	CO1 CO2 CO5	K3
III	Waste water management, source of waste water, Waste water treatment- physical, chemical and biological treatment. Microbiology of Waste water; Aerobic and anaerobic process, BOD and COD.	10	CO3	K4
IV	Toxicity: Types and Test for evaluating Toxicity. Biosensors, Biomonitoring of toxic materials .Biomagnification, Biomining and Biofuels	10	CO4	K5
V	Bioremediation; *In-situ and Ex-situ* Bioremediation of contaminated soils and waste land; Microbiology of degradation of Xenobiotics in environment; Pesticides, Surfactants, Degradative plasmids. Solid waste: Composting, Vermiculture and methane production.	15	CO5	K6
Reference Books:				

- Gareth M. Evans, Gareth G. Evans, Judy Furlong 2011
- Environmental biotechnology: theory and application John Wiley & Sons, Ltd. West Sussex, UK
- M. Moo-Young, W.A. Anderson, A.M. Chakrabarty, 2010. Environmental Biotechnology: Principles and Applications. Springer.
- M. H. Fulekar, 2010 Environmental Biotechnology, by Science Publishers Department of Life Sciences, University of Mumbai, India,
- Stanley E. Manahan, 2009. Environmental Chemistry, Ninth Edition, CRC Press.
- Environmental chemistry 5th edition by A.K.De. 1997.
- Bruce E. Rittmann and Perry L. McCarty. 2001. Environmental Biotechnology :Principles and applications. McGraw Hill, Newyork.
- Ahmed N, Qureshi, F.M. and Khan, O.Y. 2001.Industrial and Environmental Biotechnology. Horizon Press.
- Ahmed N, Qureshi, F.M. and Khan, O.Y. 2001.Industrial and Environmental Biotechnology. Horizon Press.

Useful Websites:

- lbewww.epfl.ch/LBE/Default_E.htm
- http://lbe.epfl.ch

SKILL ENHANCEMENT COURSE-1
TISSUE ENGINEERING

Title of the paper	TISSUE ENGINEERING	Subject code:	
Category of the course	Year	Semester	Credits
Extra disciplinary subject	1st	2nd	2

Learning Outcome:

The subject imparts knowledge on the fundamentals of tissue and its function. The student will be provided with a basic knowledge and understanding about the functions of tissue and its biomedical applications.

Course Outcome:

CO-1	Understand the basics of Basics of Tissue Engineering
CO-2	Apply the knowledge to create tissue culture methods
CO-3	Acquire adequate knowledge in the use of tissue in medical application
CO-4	Evaluate the benefits of Tissue Engineering & Pharmaceutical Products
CO-5	Analyze the importance of applications of tissue engineering

SYLLABUS | SKILL ENHANCEMENT COURSE | TISSUE ENGINEERING

Unit	Content	Hours	Cos	Cognitive level
I	Basic biology of tissue engineering: The basis of growth and differentiation-morphogenesis and tissue engineering	10	CO1	K4 & K5
II	In vitro control of tissue development-Growth factors-Tissue engineering bioreactors- In vitro synthesis of Tissue and organs-Organotypic and histotypic engineered tissues. 3D cell culture-Tissue assembly in microgravity	15	CO2	K3 & K5
III	Biomaterials in tissue engineering-Scaffolds, extracellular matrix, polymers and nanocomposites. Approaches to transplanting engineered cells	10	CO3	K1,K2,K3 & K4
IV	Bioartificial pancrease, Hepatassist liver support system, Artificial Womb, Heamatopoietic system: Red blood cell substitutes, Renal replacement devices	10	CO4	K2, K3, K4, K5
V	Structural tissue engineering-Bone regeneration through cellular engineering, Skin tissue engineering, Brain implants-Neural stem cells, Periodontal applications	15	CO5	K2,K3,K4 & K6

Reference Books:

- Sylvia, S. Mader, 2011, Human Biology, Twelfth edition, Mc Graw Hill, USA.
- Robert P. Lanaza, Robert Langer and Joseph Vacanti, 2007. Principles of Tissue Engineering. Third edition Academic Press.
- Micklem.H.S., Loutit John.F., 2004, Tissue grafting and radiation, Academic Press, New York..
- Penso.G., Balducci.D., 2004.Tissue cultures in biological research,Elsevier, Amsterdam
- Cecie Starr, 1996, Biology, Third edition , Wordsworth, America.

Useful Websites:

- www.nuigalway.ie/anatomy/tissue_engineering.htm

<table>
<tr><td>Title of the Course</td><td colspan="6">HUMAN RIGHTS</td></tr>
<tr><td>Paper Number</td><td colspan="6">COMPULSORY PAPER</td></tr>
<tr><td>Category SEC</td><td>Year
Semester</td><td>II
II</td><td>Credits</td><td>2</td><td>Course Code</td><td></td></tr>
<tr><td>Instructional Hours per week</td><td>Lecture
2</td><td>Tutorial
-</td><td colspan="2">Lab Practice
-</td><td colspan="2">Total
2</td></tr>
<tr><td>Course outline</td><td colspan="6">Unit – I :
Definition of Human Rights – Nature, Content, Legitimacy and Priority – Theories of Human Rights – Historical Development of Human Rights.</td></tr>
<tr><td></td><td colspan="6">Unit- II:
International Human Rights – Prescription and Enforcement upto World War II – Human Rights and the U. N. O. – Universal Declaration of Human Rights – International Covenant on Civil and Political Rights – International Covenant or Economic, Social and Cultural Rights and Optional Protocol.</td></tr>
<tr><td></td><td colspan="6">Unit –III:
Human Rights Declarations – U.N. Human Rights Declarations – U.N. Human Rights Commissioner.</td></tr>
<tr><td></td><td colspan="6">Unit-IV:
Amnesty International – Human Rights and Helsinki Process – Regional Developments – European Human Rights System – African Human Rights System – International Human Rights in Domestic courts.</td></tr>
<tr><td></td><td colspan="6">Unit-V:
Contemporary Issues on Human Rights: Children’s Rights – Women’s Rights – Dalit’s Rights – Bonded Labour and Wages – Refugees – Capital Punishment. Fundamental Rights in the Indian Constitution – Directive Principles of State Policy – Fundamental Duties – National Human Rights Commission.</td></tr>
<tr><td>Reference Magazines</td><td colspan="6">1. The Lawyer, Bombay.
2. Human Rights Today, Columbia University.
International Instruments of Human Rights, UN Publication.</td></tr>
<tr><td>Books for Reference</td><td colspan="6">1. International Bill of Human Rights, Amnesty International Publication,1988.
2. Human Rights, Questions and Answers, UNESCO,
1982.3.Mausice Cranston- What is Human Rights.
4. Desai, A.R - Violation of Democratic Rights in India.
5. Pandey - Constitutional Law.
6. Timm R.W - Working for Justice and Human Rights.7.Human Rights- A Selected Bibliography, USIS.
8.J.C. Johari - Human Rights and New World order.
9.G.S. Bajwa - Human Rights in India.</td></tr>
</table>

	10.Amnesty International - Human Rights in India. 11.P.C. Sinha & K. Cheous (Ed) - International Encyclopedia of Peace, Security, Social Justice and Human Rights (Vols. 1 - 7). 12.Devasia, V.V - Human Rights and Victimology.

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO1: Highlight the Definition of Human Rights

CLO2: State the Role of Universal Declaration of Human Rights

CLO3: Explain Human Rights Declarations

CLO4: Discuss about the International Human Rights in Domestic Courts.

CLO5: Understand about Contemporary Issues on Human Rights

	POs						PSOs		
	1	2	3	4	5	6	1	2	3
CLO1	2	1	1	2	3	3	3	2	1
CLO2	1	1	3	1	3	3	3	2	1
CLO3	2	2	1	1	3	3	3	2	1
CLO4	3	2	3	2	3	3	3	2	1
CLO5	1	1	2	3	3	3	3	2	1

Core Paper-VII

BIOINFORMATICS

Title of the paper	BIOINFORMATICS	Subject code:	
Category of the course	Year	Semester	Credits
Core Paper	2nd	3rd	5

Learning Outcome:

The paper imparts a thorough knowledge of the basics of bioinformatics tools. The student will get to understand the core concepts of in Silico biological research.

Course outcomes:

CO-1	To get introduced to the basic concepts of Bioinformatics and its significance in Biological data analysis.
CO-2	Describe the history, scope and importance of Bioinformatics and role of internet in Bioinformatics.
CO-3	Explain about the methods to characterize and manage the different types of Biological data.
CO-4	Classify different types of Biological Databases.
CO-5	Introduction to the basics of sequence alignment and analysis

SYLLABUS | Core Paper | BIOINFORMATICS				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	Database concepts, Introduction to internet and its application, Introduction to bioinformatics, Protein and nucleotide databases, Information retrieval from biological databases, Sequence alignment and database searching-similarity searches using BLAST and FASTA. Artificial Intelligence: Introduction to biological neural network, motivation for artificial neural network (ANN)	20	CO1	K1 & K2
II	Global and local alignment algorithms, multiple sequence alignment-progressive alignment and Iterative alignment algorithms, consensus sequence, patterns and profiles, Database searching: Pairwise alignment based rigorous algorithm and Heuristic algorithms (FASTA and Blast). Multiple sequence alignment based database searching. PSI- Blast, PAM and Blosum matrices	20	CO2	K2,K3 & K5

III	Finding genes in prokaryotic and eukaryotic genomes, Bioinformatics for Genome maps and markers, Bioinformatics for understanding Genome variation, Protein structure-X-ray crystallography, The protein databank and the PDB Sum-SCOP, CATH, DALI ;Visualization of molecular structures-RasMol and Pymol; Protein secondary structure prediction,	20	CO3	K2 & K5
IV	Molecular visualization tools. Structure analysis tools. VAST and DALI, Structural biology - Homology modeling, Bioinformatics for micro array designing, Bioinformatics for metabolic reconstruction, Bioinformatics for phylogenetic analysis	15	CO4	K4 & K5
V	Medical application of Bioinformatics. Disease genes, Drug Discovery. History. Steps in drug discovery. Target Identification. Target Validation. QSAR, ADME. Drug designing. Rational drug design. Computer aided drug design. Ligand based approach. Target based approach	15	CO5	K3,K4 & K6

Reference Books:

- DassanayakeS.Ranil, Y.I.N. Silva Gunawardene, 2011. Genomic and Proteomic Techniques, Narosa Publishing House Pvt. Ltd, New Delhi.
- Thiagarajan B, Rajalakshmi.P.A., 2009. Computational Biology, MJP publishers, Chennai.
- BosuOrpita, SimminderKaurThukral, 2007. Bioinformatics Databases, Tools and Algorithms, Oxford University press, New Delhi.
- Rastogi.S.C, Mendiratta.N, Rastogi.P, 2004. Bioinformatics methods and applications, Prentice-Hall of India private limited, New Delhi.
- Lohar s. Prakash, 2009. Bioinformatics, MJP Publishers, Chennai.
- Stephen misener and Stephen A. Krawetz., 2000. Bioinformatics methods and protocols, Humana press Inc, New Jersey.
- Durbin.R, S.Eddy, A.Krogh and G.Mitchison, 1998. Biological sequence analysis, Cambridge university press, Cambridge.

Core Paper-VIII

IMMUNOLOGY

Title of the paper	IMMUNOLOGY	Subject code:	
Category of the course	Year	Semester	Credits
Core Paper	2nd	3rd	5

Learning Outcome:

The paper imparts a thorough knowledge on the basics of immunology. The student will get to understand the core concepts of immune systems and their non-specific and specific mechanisms, vaccine, etc.

Course outcomes:

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

CO-1	(K2) Illustrate various mechanisms that regulate immune responses and maintain tolerance
CO-2	(K3) describe key events and cellular players in antigen presentation, and how the nature of the antigen will shape resulting effector responses
CO-3	(K4) learn the concepts of cellular and molecular processes that represents the human immune system.
CO-4	(K5) elucidate the role of immunological regulation and tolerance at a cellular and molecular level
CO-5	(K6) compile concepts on immunological principles and diagnosis

SYLLABUS | Core Paper| IMMUNOLOGY				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	History and overview of the immune system. Types of immunity - innate, acquired, passive and active, self vs non-self-discrimination. Lymphoid tissue, origin and development. Hematopoiesis and differentiation of lymphocytes	20	CO1	K1 & K2
II	Lymphocyte-sub-populations of mouse and man. APC cells, lymphokines, Phagocytic cells, macrophage, dendritic cells, K and NK Cells. Nature and biology of antigens, epitopes, haptens, adjuvents. Immunoglobulins- structure, distribution and function. Immunoglobulin super family Isotypic, Allotypic and Idiotypic variants, generation of	20	CO2	K2,K3 & K5

	antibody diversity			
III	Role of MHC antigens in immune responses. MHC antigens in transplantation and HLA tissue typing. Transplantation immunology- immunological basis of graft rejection, clinical transplantation and Immunosuppressive therapy. Tumor Immunology - Tumor antigen, Immune response to tumors	20	CO3	K2 & K5
IV	Effector mechanisms in immunity - macrophage activation, cell mediated cytotoxicity, cytotoxicity assay. Hypersensitivity reactions and types. The complement system, mode of activation, classical and alternate pathway, biological functions of C proteins	10	CO4	K4 & K5
V	Immunotechniques- Principle and Applications: Immuno diffusion, Immuno fluorescence, Insitu localization technique - FISH and GISH. RIA and ELISA, Western blot. Agglutination tests. VDRL test. Purification of antibodies, Quantitation of immunoglobulin by RID and nephelometry.	20	CO5	K3,K4 & K6

Reference Books:

- Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt,2011.
- Roitt.s Essential Immunology, 12 edition, Wiley-Blackwell. USA.
- Kannan. I., 2010. Immunology. MJP Publishers, Chennai.
- Abbas, A.K., A.H.L. Lichtman and S.Pillai, 2010. Cellular and MolecularImmunology. 6th Edition. Saunders Elsevier Publications, Philadelphia.
- SeemiGarhat Bashir, 2009. Text Book of Immunology, PHI LearningPvt. Ltd. New Delhi.
- Thomas J. Kindt, Barbara A. Osborne and Richard A. Goldsby, 2006.Kuby Immunology, 6th edition, W. H. Freeman & Company.
- Nandini Shetty, 1996, Immunology: introductory textbook - I. NewAge International, New Delhi.

Useful Websites:

- www.library.csusm.edu/course guides/biology
- www.immunologylink.com
- http://www.wiley.com/college/bio/karp12791/weblinks.html

Core Paper-IX

BIOPROCESS TECHNOLOGY

Title of the paper	BIOPROCESS TECHNOLOGY	Subject code:	
Category of the course	Year	Semester	Credits
Core Paper	2nd	3rd	5

Learning Outcome:

The paper imparts a thorough knowledge on the basics of bioprocess and industrial fermentation. The student will get to understand the core concepts of fermentation and its commercial application.

Course outcomes:

The student will learn about the:

CO-1	(K2) Outline the basis of Bioprocess Engineering
CO-2	(K3) Relate reactors in fermentation
CO-3	(K4) Differentiate fermentation processes
CO-4	(K5) Assess Scale up and Scale down
CO-5	(K6) Compile the output of fermentation processes

SYLLABUS | Core Paper | BIOPROCESS TECHNOLOGY				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	Introduction to fermentation. General requirements of fermentation. Microbial growth kinetics of batch and continuous culture. Solid substrate, slurry fermentation and its application. Microbial cell culture. Immobilization of cells and enzymes.	20	CO1	K1 & K2
II	Types of bioreactors: Submerged reactors, surface reactors, mechanically agitated reactors, non-mechanically agitated reactors. Production of citric acid, penicillin and insulin. Isolation and improvement of Industrially important Micro-organisms,	20	CO2	K2,K3 & K5
III	Introduction to bioproducts and bioseparation. Primary recovery process: Cell disruption methods. Precipitation methods. Filtration: Principles,	20	CO3	K2 & K5

	Conventional, Crossflow filtration. Sedimentation: Principles, Sedimentation coefficients. Extraction Principles, Liquid liquid extraction, aqueous two phase extraction.			
IV	Down Stream Processing: Chromatography Techniques, Membrane separation, ultrafiltration. Drying .Principles and operation of vacuum dryer, rotary dryer, Crystallization and Whole broth processing.	20	CO4	K4 & K5
V	Aerobic and anaerobic fermentation processes and their application in the field of biotechnology industry. Production of commercially important primary and secondary metabolites.	10	CO5	K3,K4 & K6

Reference Books:

- Min-tzeLiong, 2011. Bioprocess Sciences and Technology. NovaScience Pub Inc.
- Michael L.Shuler, FikretKargi. 2003. Bioprocess Engineering. PHIpublishers.
- P.A.Belter, E.L.Cursler, and W.S.Hu. 1988.Bioseparation: Downstream processing for Biotechnology. John Wiley and sons.
- R.G. Harrison, P.Todd, SR.Rudge and D.P. Petrides. 2003.Bioseparation science and engineering. Oxford Press.

Useful Websites:

- www.wildfermentation.com/John Schollar and BenedikteWatmore, Practical Fermentation-a technicalguide
- web.mit.edu/professional/short.../fermentation_technology.html

PRACTICAL-3

(Bioinformatics, Immunology & Bioprocess Technology)

Title of the paper	PRACTICAL-III (Bioinformatics, Immunology & Bioprocess Technology)	Subject code:	
Category of the course	Year	Semester	Credits
Core Paper	2nd	3rd	4

Learning Outcome:

The practical will establish a basic study skill on the subject and will improve the student's ability to calculate and improve their practical skill and knowledge.

Course outcomes:

CO-1	(K2) to learn the Bioinformatics tools for sequence retrieval and alignment
CO-2	(K3) to apply the learned tools for various applications
CO-3	(K4) to isolate, identify & enumerate immune cells
CO-4	(K5) to learn the technique of immunodiagnostics
CO-5	(K6) to study upstream & downstream techniques

SYLLABUS | PRACTICAL-3				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
A	**(A) Bioinformatics-practical** 1. Sequence retrieval from Genbank 2. Sequence retrieval from Uniprot. 3. Sequence identity search- Sequence similarity search using BLAST 4. Sequence similarity search using FASTA 5. Sequence similarity search using PSI BLAST 6. Sequence similarity search using PHI- BLAST. 7. Sequence translation using ExPASy translate tool 8. Characterization of retrieved protein sequence by ProtParam tool. 9. PHYLOGENY- Phylogenetic tree using PHYLIP. 10. Prediction of secondary protein structure using GOR (Garnier Osguthorpe-Robson) server. 11. Prediction of tertiary protein structure using SWISS-MODEL Server 12. Validation of the predicted structure using PROCHECK server 13. Molecular visualization of proteins using RASMOL. 14. Docking of small molecule with protein structure using Hex software.	15	CO1 CO2 CO3 CO4 CO5	K1,K2,K3,K4 &K5

	15. Docking of two proteins using PatchDock (Protein-Protein docking) tool. 16. Retrieval of E.Coli glycolytic pathway from KEGG			
B	**(B) Immunology - practical** 1. Identification of various immune cells from human peripheral blood. 2. WBC counting 3. Preparation of serum and plasma 4. Immunodiagnostics: CRP 5. Immunodiagnostics: ASO 6. Immunodiagnostics: Widal 7. Immunodiagnostics: RA 8. Immunodiagnostics: Blood grouping and typing 9. Radial Immunodiffusion 10. Ouchterlony Immunodiffusion 11. Immunoelectrophoresis	15	CO1 CO2 CO3 CO4 CO5	K2,K3,K4
C	**(C) Bioprocess Technology - Practical** 1. Parts and design of fermenter 2. Foaming and antifoaming agents 3. Media preparation and sterilization 4. Isolation of industrially important microorganisms for microbial processes. 5. Conservation of Bacteria by Lyophilization. 6. Production and estimation of amylase. 7. Production of wine using grapes 8. Production of penicillin 9. Determination of penicillin activity 10. Use of alginate for cell immobilization. 11. Cell disruption	15	CO1 CO2 CO3 CO4 CO5	K2,K3,K4 & K5

Elective Paper-V

NANO BIOTECHNOLOGY

Title of the paper	NANO BIOTECHNOLOGY	Subject code:	
Category of the course	Year	Semester	Credits
Elective Paper	2nd	3rd	3

Learning Outcome:

The subject imparts knowledge on the fundamentals of nanoparticles. The student will be provided with a basic knowledge and understanding about the role of nanoparticles in biotechnology.

Course outcomes:

CO-1	Understand the bases for Introduction to Nanotechnology
CO-2	To impart understanding on Nanoparticle based Drug Delivery.
CO-3	Fabrication of nanomaterials for bone tissue grafting
CO-4	Methods of Nanofabrication
CO-5	Understand the application of Nanotechnology

SYLLABUS | Elective Paper | NANO BIOTECHNOLOGY				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	Introduction to Nanotechnology, Classification of nanobiomaterials -Types of nanomaterials – nanoparticles, nanotubes, nanowires, Nanofibers, Size deoendent variation in the properties of Nanomaterials.	9	CO1	K1
II	Preparation of Nanomaterials, Top down and bottom up approaches, Biosynthesis, Nanobiomaterials-Metal based Nanobiomaterials, Carbon based Nanomaterials, DNA based Nanostructures, Protein based Nanostructures, Magnetic Nanoparticles, Nanofibres, Hydrogels.	9	CO2	K4
III	Application of Nano materials, Food and Cosmetic applications, Bio-sensors and Lab-on-a-chip, Bio-devices and implantable devices, Bioremediation, Application of Nanotechnology in textile industry.	9	CO3	K1 & K5
IV	Nanomaterials for diagnosis and therapy, Implications of drug delivery, Nano-carriers for application in medicine, Drug release mechanism, Targeted Drug Delivery using nanocarriers, Nanoparticle technologies for cancer therapy and diagnosis,	9	CO4	K2
V	Nanotoxicology, Portals of Entry of the nanoparticles into the Human Body, Biological response and	9		K5

	cellular interaction of implant materials and scaffolds, Risk assessment and Safety Regulation of nanoparticles.		CO5	

Reference Books:

- Nanotechnology, S.Shanmugam, Mjp publication. 2011.
- Advanced nanomaterials, kurt E. geckeler, Hiroyuki Nishide , Wiley VHC.2010.
- Nanotechnology and tissue engineering. T.Laurencin, Lakshmi S. Nair, CRC press. 2012.
- Handbook of carbon nanomaterials. Francis D souza, Karl M. Kadish.
- World scientific publishing co. pte. ltd. 2011.
- Oded Shoseyov (Editor), Ilan Levy, 2010. NanoBioTechnology: BioInspired Devices and Materials of the Future, Humana Press.
- Chad A. Mirkin and Christof M. Niemeyer, 2007. Nanobiotechnology II: More Concepts and Applications, Wiley-VCH.
- Challa S.S.R.Kumar (Ed). 2006. Biologicals and pharmaceutical nanomaterials, Wiley-VCH Verlag Gmbh & Co, KgaA.
- K.K.K.Jain 2006. Nanobiotechnology in Molecualr Diagnostics: Current Techniques and Applications Horizon Bioscience
- Niemeyer, C.M., Mirkin, C.A. (Eds). 2004. Nanobiotechnology Concepts, Applications and Perspectives, Wiley-VCH, Weinheim.
- Andrze w. Miziolek, Shashi P.Karna, J malthew Mauro and Richard A.Vaia. 2005 Defense Applications of Nanomaterials :
- Springer Handbook of Nanotechnology- Ed. by B. Bhushan, Springer-Verlag (2004)
- The Chemistry of Nanomaterials: Synthesis, Properties and Applications, C.N.R. Rao, A. Muller, A. K. Cheetham (Eds), Wiley-VCH Verlag (2004)
- Nanomaterials for medical diagnosis and therapy, Challa Kumar, Wiley-VCH, 2007.
- Nanotechnology for cancer therapy, Mansoor M. Amiji, CRC Press, 2007.
- K.K.Jain, Nano Biotechnology, Horizions Biosciences, 2006
- Nanomaterials: An introduction to synthesis, properties and application, Dieter Vollath, Wiley VCH, 2008
- Cato T. Laurencin and Lakshmi S. Nair, Nanotechnology and Tissue Engineering The
- Scaffold, CRC Press taylor& Francis Group.
- Introduction to Nanoscience and Nanotechnology, Gabor .L et al, Fundamentals of Nanotechnology, Hornyak, G. Louis, Tibbals, H. F., Dutta, Joydeep, CRC Press, 2009.
- Assessing Nanoparticle Risks to Human Health, Gurumurthy Ramachandran, Elesvier, 2011.
- Nanotechnology: Environmental Health and safety, Risks, Regulation and Management, Matthew Hull and Diana Bowman, Elsevier, 2010.
- Nanotechnology: Health and Environmental Risks, Jo Anne Shatkin, CRC Press, 2013

Useful Websites:

http://www.zyvex.com/nano www.fda.gov/nanotechnology/ www.nature.com/nnano/

Elective Paper-V

MOLECULAR DEVELOPMENTAL BIOLOGY

Title of the paper	MOLECULAR DEVELOPMENTAL BIOLOGY	Subject code:	
Category of the course	Year	Semester	Credits
Elective Paper	2nd	3rd	3

Learning Outcome:

The subject imparts knowledge on the fundamentals of developmental biology. The student will be provided with a basic knowledge and understanding about the molecular aspects of developmental biology.

Course outcomes:

CO-1	Illustrate the structure and function of developmental biology, Gametogenesis
CO-2	Discuss basic fertilization process of animals
CO-3	Demonstrate the functions of embryonic development process
CO-4	Illustrate the organ development of vertebrate animals
CO-5	Demonstrate the impact of gene in developmental biology and developmental disorders

SYLLABUS | Elective Paper| MOLECULAR DEVELOPMENTAL BIOLOGY				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	Definition and scope of developmental biology. Gametogenesis - Spermatogenesis and Oogenesis. Structure of Sperm and oocyte. Instructive and permissive interactions, competence, epithelial - mesenchymal interactions. Important signaling pathways in vertebrate development	9	CO1	K1,K2 & K5
II	Fertilization - Definition, mechanism of fertilizatiom in mammal & sea urchin. Types of fertilization. Nieuwkoop center, Molecular role of organizer	9	CO2	K4
III	Cleavage in Xenopus, Chick and mammals, Regulation of cleavage cycle. Morphogenetic movements, Gastrulation in Xenopus, Chick and mammals. Fate Maps	9	CO3	K3
IV	Vertebrate Development: Formation of the neural tube, myogenesis, and hematopoiesis. Mechanism of	9	CO4	K2

	vertebrate eye development			
V	Drosophila Maternal effect genes, induction at single cell level - differentiation of photoreceptors in ommatidia. Developmental disorders Spina bifida, Anenecephaly, and craniorachischis, Cyclopia, Thanotrophic dysplasia	9	CO5	K1 & K4

Reference Books:

- Scott F.Gilbert, 2010. Developmental Biology, 9th edition, Sinauer Associates Inc.
- Subramoniam, T. 2002. Developmental Biology. 1st edition. Narosa publications.
- Richard M.Twynman, 2001 Developmental Biology. (2 nd edition), Viva Publications, New Delhi.

Useful Websites:

sackler.tufts.edu/.../Cell-Molecular-and-Developmental-Biology www.devbio.com/

INTERNSHIP

Title of the paper	INTERNSHIP	Subject code:	
Category of the course	Year	Semester	Credits
Paper	2nd	3rd	2

Learning Outcome:

To gain hands on training and expertise in handling sophisticated instruments and acquire in depth knowledge in their applications.

Course outcomes:

The student will learn to

CO-1	(K2) understand working principles and the techniques of various processes
CO-2	(K3) apply standard operating procedures followed in industries
CO-3	(K3) prepare to face challenges & gain confidence in the field of study.
CO-4	(K5) critically assess the utilization of sophisticated instruments and expensive consumables
CO-5	(K6) develop work ethics to be followed in a scientific laboratory

SKILL ENHANCEMENT COURSE-2

GENE MANIPULATION TECHNOLOGY

Title of the paper	GENE MANIPULATION TECHNOLOGY	Subject code:	
Category of the course	Year	Semester	Credits
Extra disciplinary subject	2nd	3rd	2

Learning Outcome:

After studying this course, students will be able to:

- To understand more about the science that underlies the development of genetically modified organisms and in particular how gene transfer is brought about
- To know something of the potential benefits and uncertainties associated with gene transfer and the high levels of technical ingenuity involved
- To understand more the science that underpins the development of Golden Rice and understand why the usefulness of this product has proved so contentious.

Course Outcome:

CO-1	Understand the basics of Basics of Gene Manipulation Technology
CO-2	Apply the knowledge to create Constructions of DNA Libraries Constructions of DNA Libraries.
CO-3	Acquire adequate knowledge in the use of Genome Sequencing and Transcriptomics
CO-4	Evaluate the benefits of Protein Engineering & Pharmaceutical Products
CO-5	Analyse the importance of Gene Cloning & Applications of Gene Cloning

SYLLABUS | SKILL ENHANCEMENT COURSE | GENE MANIPULATION TECHNOLOGY				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	Basics of Gene Manipulation Technology,Restriction Enzymes-Cutting and Joining Reactions-Selection of Recombinants- Agarose Gel Electrophoresis-Southern Blotting- Hybridization-PCR- Native Page- SDS-	9	CO1	K2,K4 &K5

	Page-2D Gel Electrophoresis.			
II	Constructions of DNA Libraries, Chromosome Walking- Positive Selection and Subtractive Hybridization- Preparation Of (BAC/YAC Library).	9	CO2	K1,K3,K5
III	Genome Sequencing and Transcriptomics- Sanger's Sequencing, Whole Genome Shot gun Sequencing- Comparative Genome Sequencing- Transcriptome Analysis- DNA Microarray.	9	CO3	K1,K2,K3 &K4
IV	Protein Engineering & Pharmaceutical Products- Site Directed Mutagenesis- Protein Analysis- Therapeutic Protein- Vaccines.	9	CO4	K2,K3 &K4
V	Applications of Gene Cloning- creating Transgenic Animals and Plants- Reporter Genes- Animal Cloning, Gene expression in plants- Biosafety and Bioethics.	9	CO5	K2,K3 &K4

References:

- An Introduction Gene Cloning And Manipulation- Howe.C
- Molecular Cloning: A Laboratory Manua l (3- Volume Set)- Sambrook J. et al.
- T.A. Brown 1995. Gene Cloning and Introduction.
- Thiel 2002. Biotechnology Nucleic Acids to Protein: A Laboratory Project. Tatamcgraw.Hill
- Desmond S. T. Nicholl, an Introduction To Genetic Engineering 3rd Edition.
- R. W. Old & S.B. Primrose, Principles Of Gene Manipulation, Fifth Edition, Blackwell Science
- Genetic Engineering Principles And Methods By Setlow, Jane K. (VOLUME 24)
- Bernard R Glick and Jack .J. Pasternack, 1994, Molecular Biotechnology, ASM Press.

Core Paper-XI

RESEARCH METHODOLOGY

Title of the paper	RESEARCH METHODOLOGY		Subject code:
Category of the course	Year	Semester	Credits
Core Paper	2nd	4th	5

Learning Outcome:

The paper imparts a thorough knowledge on the basics of academic research. The student will get to understand the core concepts of methodologies & ethics to pursue research.

Course outcomes:

CO-1	Understand the bases for research
CO-2	To know about research proposal and dissertation writing.
CO-3	To know about Statistical application in research
CO-4	To know about office tools used in research
CO-5	To know about search engines.

SYLLABUS | Core Paper | RESEARCH METHODOLOGY				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	Research Methodology - An Introduction: Meaning of Research, Objectives of Research, Types of Research, Criteria of good research. Defining the Research Problem; Research Design; Sampling Design; Methods of Data Collection; Processing and Analysis of Data.	20	CO1	K1
II	Review of literature, Writing the Research Report (Thesis and publications): Components of research report - Title, Authors, Addresses, Abstract, Keywords, Introduction, Materials and Methods, Results, Discussion, Summary, Acknowledgements and Bibliography	20	CO2	K2 &K6
III	Standard Deviation- T test. Analysis of Variance components (ANOVA) for fixed effect model; Total, treatment and error of squares, Degrees of freedom,	20	CO3	K3

	Confidence interval; ANOVA for random effects model, Estimation of variance components, Model adequacy checking.			
IV	Spreadsheet Tool: Introduction to spreadsheet application, features and functions. Presentation Tool: Introduction to presentation tool, features and functions, Creating presentation, Customizing presentation, Showing presentation. Tools used may be Microsoft Power Point, Open Office or similar tool	20	CO4	K1 & K4
V	Web Search: Introduction to Internet, Use of Internet and WWW, Using search engine like Google, Yahoo, Pubmed, Science direct, Scopus and Using advanced search techniques	10	CO5	K1 & K2

Reference Books:

- Montgomery, Douglas C. (2007), 5/e, Design and Analysis of Experiments, (Wiley India).
- Montgomery, Douglas C. & Runger, George C. (2007), 3/e, Applied Statistics & Probability for Engineers (Wiley India).
- Kothari C.K. (2004), 2/e, Research Methodology- Methods and Techniques (New Age International, New Delhi).
- Krishnaswamy, K.N., Sivakumar, Appa Iyer and Mathiranjan M. (2006), Management Research Methodology; Integration of Principles, Methods and Techniques (Pearson Education, New Delhi).
- The complete reference Office Xp – Stephan L. Nelson, Gujulia Kelly (TMH).
- Basic Computer Science and Communication Engineering – R. Rajaram (SCITECH).

Useful Websites

- www.ask.com/Methodology+Research
- www.qmethod.org/

Core Paper-XII

BIOSTATISTICS

Title of the paper	BIOSTATISTICS	Subject code:	
Category of the course	Year	Semester	Credits
Core Paper	2nd	4th	3

Learning Outcome:

The paper imparts a thorough knowledge on the basics of all the statistical concepts, in biology. The student will get to understand the core concepts of computation principles for the data analysis.

Course outcomes:

At the end of the Course, the Student will be able to:

CO-1	To understand the major Methods of collection & presentation of data
CO-2	To provide basic knowledge about methods of analysis of variance
CO-3	To enlighten the students about the methods of setting hypothesis and calculation of errors.
CO-4	To update the knowledge on Tests of significance for large and small samples.
CO-5	To assess and appraise the role of novel microbes in environment and integrate them in specific innovative approaches.

SYLLABUS | Elective Paper| BIOSTATISTICS				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	Statistics – Scope –collection, classification, tabulation of Statistical Data – Diagrammatic representation – graphs – graph drawing – graph paper – plotted curve –Sampling method and standard errors –random sampling – use of random numbers – expectation of sample estimates – means, Measures of central tendency – measures of dispersion – skewness, kurtosis, moments	20	CO1 CO2 CO3	K1,K2,K3 & K4
II	Correlation and regression – correlation table – coefficient of correlation – Z transformation – regression – relation between regression and correlation. Probability – Markov chains applications – Probability distributions – Binomial (Gaussian distribution) and negative binomial, compound and	20	CO1 CO2 CO5	K1,K2,K3 & K4

	multinomial distributions – Poisson distribution			
III	Normal distribution – graphic representation.– frequency curve and its characteristics –measures of central value, dispersion, coefficient of variation and methods of computation – Basis of Statistical Inference – Sampling Distribution – Standard error – Testing of hypothesis – Null Hypothesis –Type I and Type II errors	20	CO1 CO4 CO5	K1,K2,K3 & K4
IV	Tests of significance for large and small samples based on Normal, t, z distributions with regard to mean, variance, proportions and correlation coefficient – chi-square test of goodness of fit – Fisher and Behrens 'd' test – 2×2 table – testing heterogeneity – r X c table – chi-square test in genetic experiments – partition X 2 – Emerson's method	20	CO1 CO2 CO3	K1,K2,K3 & K4
V	Tests of significance –t tests – F tests – Analysis of variance – one way classification – Two way classification, CRD, RBD, LSD. Spreadsheets – Data entry –mathematical functions – statistical function – Graphics display – printing spreadsheets – use as a database word processes – databases – statistical analysis packages graphics/presentation packages	10	CO1 CO2 CO4 CO5	K1,K2,K3 & K4

References Books:

- Veer bala Rastogi. 2011. Fundamentals of Biostatistics. Ane books Pvt Ltd, Chennai.
- Rosner,B (2005), "Fundamentals of Biostatistics", Duxbury Press.
- Warren,J; Gregory,E; Grant,R (2004), "Statistical Methods in Bioinformatics",1st edition, Springer
- Milton,J.S.(1992),. "Statistical methods in the Biological and Health Sciences", 2nd edition ,Mc Graw Hill,
- Sundar Rao P. S.S., Jesudian G. & Richard J. (1987), "An Introduction to
- Biostatistics", 2nd edition,. Prestographik, Vellore, India,.
- Zar, J.H. (1984) "Bio Statistical Methods", Prentice Hall, International Edition

Useful Websites:

- www.statsoft.com/textbook/ biosun1.harvard.edu/
- www.bettycjung.net/Statsites.htm

- www.ucl.ac.uk/statistics/biostatistics

Elective Paper –VI
INDUSTRIAL EFFLUENT TREATMENT

Title of the paper	**INDUSTRIAL EFFLUENT TREATMENT**		Subject code:
Category of the course	Year	Semester	Credits
Elective Paper	2nd	4th	3

Learning Outcome:

The paper imparts a thorough knowledge on the basics of academic research. The student will get to understand the core concepts of methodologies & ethics to pursue research.

Course outcomes:

CO-1	Ability to plan minimization of industrial wastes
CO-2	Ability to design facilities for the processing and reclamation of industrial waste water.
CO-3	Understand the design and working principle of various treatment methods.
CO-4	Manage sewage and industrial effluent issues.
CO-5	Develop the critical thinking on management of hazardous waste.

SYLLABUS | ELECTIVE PAPER | INDUSTRIAL EFFLUENT TREATMENT				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	Types of industrial wastes –Biodegradable industrial waste and Non – biodegradable industrial waste. Sources of wastes - municipal, medical, agriculture, industry, electronic, construction and demolition. Characteristics of industrial wastes – effects of industrial effluents on air, land, water and land.	15	CO1	K1
II	Sources, Characteristics, waste treatment flow sheets for selected industries such as Textiles, Tanneries, Pharmaceuticals, Dairy, Sugar, Paper, distilleries, Refineries, fertilizer.	15	CO2	K2 &K6
III	Effluent Treatment Plant – Need, design, mechanism, level of treatment – primary, secondary and tertiary, advanced technology for tannery treatment - ETP Process Design for a typical tannery industry.	10	CO3	K3
IV	Microbial degradation of plastics, oil, metals – biotechnological methods for management of pollution – atmospheric CO2 reduction – sewage treatment.	10	CO4	K1 & K4
V	Hazardous wastes – types – sources – effects; management - Membrane filtration, Nano-filtration - Physico chemical treatment – solidification – incineration – Secured landfills	10	CO5	K1 & K2

Books for Study:

1. Rao M. N. & Dutta A. K. ―Wastewater Treatment‖, Oxford – IBH Publication, 1995.
2. Eckenfelder W.W. Jr., ―Industrial Water Pollution Control‖, McGraw Hill Book Company, New Delhi, 2000.
3. Patwardhan. A.D., Industrial Wastewater Treatment‖, Prentice Hall of India, New Delhi 2010.
4. Wastewater Treatment by M. N. Rao and A. K. Datta–Oxford I. B. H publishers
5. Industrial Wastewater Management, Treatment and Disposal‖ (WEF – MOP – FD3) McGraw Hill, 2008.

Elective Paper-VI

BIOFERTILIZER AND ORGANIC FARMING

Title of the paper	**BIOFERTILIZER AND ORGANIC FARMING**		Subject code:
Category of the course	Year	Semester	Credits
Elective Paper	2nd	4th	3

Learning Outcome:

The paper imparts a thorough knowledge on the basics of academic research. The student will get to understand the core concepts of methodologies & ethics to pursue research.

Course outcomes:

CO-1	To understand about the importance of biofertilizer.
CO-2	To learn about the symbiotic relations of nitrogen fixers.
CO-3	To demonstrate the knowledge of ecofriendly agricultural inputs in biofertilizer production.
CO-4	To understand the importance of organic farming.
CO-5	Build the practical knowledge on biofertilizers and composting methods.

SYLLABUS | ELECTIVE PAPER | BIOFERTILIZER AND ORGANIC FARMING				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	Introduction and scope of Biofertilizers. History of biofertilizers production. Types and classification of Biofertilizers.	10	CO1	K1
II	Structure, characteristic features and mass Production of bacterial biofertilizers- Rhizobium, Azospirillum and Azotobacter; Cyanobacterial biofertilizers- Blue – Green algae, Nostoc.	15	CO2	K2 &K6
III	Fungal biofertilizers- Vesicular – arbuscular Mycorrhizal Fungi (VAM Fungi). Azolla and application in rice fields. Phosphate solubilizing microbes - Isolation, characterization, mass inoculum production, field application – plant based biofertilizer – neem – animal based biofertilizer – fish	15	CO3	K3
IV	Introduction, status, Components, Concepts, principles and applications of Organic farming – advantages and disadvantages – beneficial and non beneficial insects – common insecticides and pesticides -Production of Biogas and its applications	10	CO4	K1 & K4
V	Green manuring and organic fertilizers, Recycling of biodegradable municipal and agricultural waste – Vermicomposting - types and method for municipal and agricultural waste – field Application	10	CO5	K1 & K2

Books for Study:

1. Dubey, R.C., 2005 A Text book of Biotechnology S. Chand & Co, New Delhi.
2. Kumaresan, V. 2005, Biotechnology, Saras Publications, New Delhi.
3. Kannaiyan, S. (2003). Biotechnology of Biofertilizers, CHIPS, Texas.
Mahedra K. Rai (2005). Hand book of Microbial biofertilizers, The Haworth Press, Inc. New York

5. Sathe, T.V. 2004 Vermiculture and Organic Farming. Daya publishers.
6. Vayas,S.C, Vayas, S. and Modi, H.A. 1998 Bio-fertilizers and organic ¬ Farming AktaPrakashan, Nadiad.
7. Palaniappan, S.P., &Annadurai, 2016.Organic Farming: Theory and Practice, Scientific Publishers, Jodhpur

Books for Reference:

1. Bagyaraj, D.J. and A. Manjunath. 1990. Mycorrhizal symbiosis and plant growth, Univ. of Agricultural Sciences, Bangalore, India.
2. Purohit, S.S., P.R. Kothari and S.K. Mathur, 1993. Basic and Agricultural Biotechnology, Agro Botanical Pub. India.

3. Subba Rao, N. S. 1988. Biological nitrogen fixation: recent developments, Mohan Primlani for Oxford and IBH Pub. Co. (P) Ltd., India.
4. Subba Rao, N.S., G.S. Venkataraman and S. Kannaiyan 1993. Biological nitrogen fixation, ICAR Pub., New Delhi.
5. Somani, L.L., S.C. Bhandari, K.K. Vyas and S.N. Saxena. 1990. Biofertilizers, Scientific Publishers - Jodhpur.
6. Reddy, S.R., 2017. Principles of Organic Farming, Kalyani Publishers, New Delhi.

Elective Paper-VI

BIOENTREPRENEURSHIP

Title of the paper	**BIOENTREPRENEURSHIP**	Subject code:	
Category of the course	Year	Semester	Credits
Elective Paper	2nd	4th	3

Learning Outcome:

The paper imparts a thorough knowledge on the basics of academic research. The student will get to understand the core concepts of methodologies & ethics to pursue research.

Course outcomes:

CO-1	Students will be able to identify the Biotech based companies, products, services and IPR
CO-2	Will understand the Business proposal for starting a company
CO-3	Will know the funding of biotech business
CO-4	Will aspire to set up Biotech enterprises
CO-5	Will analyse the Financial requirement for bioentrepreneurship

SYLLABUS | ELECTIVE PAPER | BIOENTREPRENEURSHIP				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	Innovation and bioentrepreneurship: Innovation as strategy in Biotech Companies – Biotechnology based products and services – license and protection – IPR issues in bioentrepreneurships – biosafety.	10	CO1	K1
II	Major start-ups in Biotechnology, Concept and theories of Entrepreneurship, Entrepreneurial traits and motivation, Nature and importance of Entrepreneurs, Government schemes for commercialization of technology (eg. Biotech Consortium India Limited)	15	CO2	K2 &K6
III	Funding of biotech business - funding for biotech in India - support mechanisms for entrepreneurship - Bioentrepreneurship efforts in India, difficulties in India experienced, organizations supporting biotech growth, areas of scope, biotech policy initiatives	15	CO3	K3
IV	Biotech enterprises: Desirables in start-up, Setting up Small, Medium & Large scale industry, Quality control in Biotech industries, Location of an enterprise, steps for starting a small industry, incentives and subsidies, exploring export Possibilities	10	CO4	K1 & K4
V	Financial analysis: Ratio analysis, Investment process, Break even analysis, Profitability analysis, Budget and planning process.	10	CO5	K1 & K2

Books for Study:

1. The Business of Biotechnology: From the Bench of the Street: By Richard Dana Ono Published Butterworth- Heinemann, 1991.
2. Entrepreneurship in Biotechnology: Managing for growth from start-up By Martin Gross Mann, 2003
3. Innovation and entrepreneurship in biotechnology: Concepts, theories & cases by D. Hyne & John Kapeleris, 2006

Books for Reference:

1. Dynamics of Entrepreneurial Development and Management by Vasant Desai, Himalaya Publishing House, 2005.
2. Projects Planning Analysis, Selection, Implementation & Review by Prasannan.
3. Best Practices in Biotechnology Education: By Yali Friedman, Published by Logos Press, 2008.

SKILL ENHANCEMENT COURSE-3

STEM CELL BIOLOGY

Title of the paper	STEM CELL BIOLOGY	Subject code:	
Category of the course	Year	Semester	Credits
Elective Paper	2nd	4th	2

Learning Outcome:

The subject imparts knowledge on the fundamentals of stem cells. The student will be provided with a basic knowledge and understanding about the application of stem cell biology.

Course Outcomes:

At the end of the Course, the Student will be able to:

CO1	To understand the major discoveries of stem cell biology
CO2	To provide basic knowledge about stem cell niche and functions
CO3	To enlighten the students on Stem cell isolation and culture techniques
CO4	To update the knowledge on Stem cell cycle
CO5	To assess and appraise Applications of Embryonic stem cells.

SYLLABUS | Elective Paper| STEM CELL BIOLOGY				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	Stem cells - Definition, Characterization, Pluripotency, Self-renewal and differentiation. Types of stem cells- Embryonic stem cells, Adult stem cells and mesenchymal stem Cells, Adipose stem cells	7	CO1	K1
II	Stem cell niche, Niche specification - Drosophila germ line stem cells. Receptors, genes and markers of stem cells	7	CO2	K1 & K2
III	Stem cell isolation and culture techniques. Characterization of stem cells	7	CO3	K3, K4
IV	Stem cell cycle. Chromatin modification and transcriptional regulation, chromatin modifying factors, Chromosomal inactivation. JAK -STAT pathway, Ras\Raf pathway, PI3K cell signaling, p53 check points, Role of LIF pathway in cell cycle control	7	CO4	K3,K3 & K5
V	Applications of Embryonic stem cells, Bone marrow stem cells, Adipose derived stem cells and	7	CO5	K3,K4 & K5

	Hematopoietic stem cells. Ethics in human stem cell research			

Reference Books:

- Stem Cell Biology, Daniel Marshak, Richard L. Gardener and David Gottlieb, Cold Spring Harbour Laboratory Press
- Stem cell biology and gene therapy, Booth C., Cell Biology International, Academic Press
- Stem Cell and Gene-Based Therapy: Frontiers in Regenerative Medicine, Alexander Battler, Jonathan Leo, Springer, STEM CELL TECHNOLOGY Syllabus - Semester First References:
- Stem Cell Biology and Gene Therapy. Quesenberry PJ, Stein GS, eds. (£65.00.) Wiley, 1998.
- Progress in gene therapy, Volume 2,Pioneering stem cell/gene therapy trials, Roger Bertolotti, Keiya Ozawa and H. Kirk Hammond, VSP international science publishers
- Stem Cells Handbook: Stewart Sell, Humana Press; Totowa NJ, USA; Oct. 2003,
- Human Embryonic Stem Cells: The Practical Handbook by Stephen Sullivan and Chad A Cowan
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SKILL ENHANCEMENT COURSE-3

BIOETHICS, BIOSAFETY, CLINICAL TRIALS, IPR & ENTREPRENEURSHIP

Title of the paper	BIOETHICS, BIOSAFETY, CLINICAL TRIALS, IPR & ENTREPRENEURSHIP	Subject code:	
Category of the course	Year	Semester	Credits
Elective Paper	2nd	4th	2

Learning Outcome:

This course provides the guidelines and regulations governing research; evaluate ethical conduct and social responsibilities; to adhere to safe working practices; to appreciate the need for protection of human subjects; to recognize the potential harms in research and show sensitivity to cultural and ethical issues; to create a general awareness about IPR.

Course Outcome:

CO-1	Understand the basics of biosafety and bioethics and its impact on biological sciences and the importance of human life.
CO-2	Apply the knowledge to recognize the importance of biosafety guidelines and good clinical practices.
CO-3	Acquire adequate knowledge in the use of genetically modified organisms and its effect on human health.
CO-4	Evaluate the benefits of GM technology and importance of IPR
CO-5	Analyse the importance of protection of new knowledge and innovations and its role in business and entrepreneurship

SYLLABUS | Elective Paper | BIOETHICS, BIOSAFETY, CLINICAL TRIALS, IPR & ENTREPRENEURSHIP				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	Introduction to Bioethics Need for bioethics in social and cultural issues. Bioethics & GMO's Issues and concerns pertaining to Genetically modified foods & food crops, Organisms and their possible health implications and mixing up with the gene-pool. Bioethics in Medicine Protocols of ethical concerns related to prenatal diagnosis, gene therapy, Organ transplantation, Xenotransplantation, Containment facilities for genetic engineering experiments, regulations on field experiments and release of GMO`s labeling of GM foods.	10	CO1	K2,K3 & K4

II	Clinical trials –Regulations. Bioethics & Cloning Permissions and Procedures in Animal Cloning, Human cloning, Risks and hopes. Bioethics in Research Stem cell research, Human Genome Project, Use of animals in research, human volunteers for Clinical research, Studies on Ethnic races. Ethics in patient care, Informed consent.	10	CO2	K3, K4 & K5
III	Biosafety – Biological risk assessment. Biological agents and Hazard groups. Criteria in biological risk assessment. Guidelines for categorization of genetically modified plants for field test. Regulation, national and international guidelines of Biosafety, rDNA guidelines, Regulatory requirements for drugs and Biologics GLP. Biosafety levels. Safety equipments and Biological Safety cabinets.	10	CO3	K3,K4 & K5
IV	IPR: Introduction to Intellectual Property rights, Patenting – Factors for patentability – Novelty, Non-obviousness, Marketability. Procedures for registration of Patents. Copyright works, ownership, transfer and duration of Copyright. Renewal and Termination of Copyright. Industrial Designs - Need for Protection of Industrial Designs. Procedure for obtaining Design Protection. Infringement, Right of Goodwill, Passing Off. Trademarks - Introduction to Trademarks. Need for Protection of Trademarks. Classification of Trademarks. Indian Trademarks Law. Procedural Requirements of Protection of Trademarks	10	CO4	K4, K5 & K6
V	Geographical Indications - Indication of Source and Geographical Indication. Procedure for Registration, Duration of Protection and Renewal. Infringement, Penalties and Remedies. Layout- Designs of Integrated Circuits: Conditions and Procedure for Registration. Duration and Effect of Registration Protection of Plant variety and Plant breeders' rights	10	CO5	K4,K5 & K6

	in India. Protection of traditional knowledge, Bioprospecting and biopiracy. India's new IP Policy (2016), Govt of India's steps to promote IPR. Career opportunities in IP. Entrepreneurship: Definition and importance, Characteristics and functions of an entrepreneur.			

Reference Books:

- "Bioethics & Biosafety" by Sateesh MK, IK International publications, 2008
- USPTO Web Patent Databases at: www.uspto.gov/patft
- Government of India's Patents Website: patinfo.nic.in
- Intellectual property India: www.ipindia.nic.in
- "Indian Patent Law : Legal and Business Implications" by Ajit Parulekar, Sarita D'Souza Macmillan India publication, 2006
- "Agriculture and Intellectual Property Rights", edited by: Santaniello,V., Evenson, R.E., Zilberman, D. and Carlson, G.A. University Press publication, 2003
- Research papers and Reports provided from time to time
- Ganguli P, (2001), Intellectual Property Rights, Tata Mcgraw Hill.
- Ramesh Chandra, (2004), Issues Of Intellectual Property Rights, Isha Books.
- Erbisch F.h., Maredia K.M, (2000), Intellectual Property Rights In Agricultural Biotechnology, Universities Press.
- Shiv Sahai Singh, (2004), Law Of Intellectual Property Rights, Deep & Deep Publications (p) Ltd.
- Subbian A, Bhaskaran S, (2007), Intellectual Property Rights: Heritage, Science And Society Int. Treaties, Deep & Deep Publications.
- Elad Harison (2008). Intellectual Property Rights, Innovation and Software Technologies. Edward Elgar Publishing Limited, UK.

DISSERTATION

Title of the paper	DISSERTATION	Subject code:	
Category of the course	Year	Semester	Credits
Core Paper	2nd	4th	7

Learning Outcome:

The paper imparts a thorough knowledge on the basics of academic research. The student will get to understand the core concepts of pursuing research