



# **PERIYAR UNIVERSITY**

**Salem – 636 011, Tamil Nadu, India**

**NAAC A<sup>++</sup> Grade State University – NIRF Rank 59**

## **DEPARTMENT OF BIOTECHNOLOGY**

**M.Sc**

**BIOTECHONOLOGY**

**SYLLABUS**

**(Choice-Based Credit System)**

**FROM THE ACADEMIC YEAR**

**2023-24**

**TANSICHE REGULATIONS ON LEARNING OUTCOME-BASED CURRICULUM  
FRAMEWORK FOR POSTGRADUATE EDUCATION IN PERIYAR UNIVERSITY**

<b>Programme</b>	<b>M.Sc. BIO-TECHNOLOGY</b>
<b>Programme Code</b>	
<b>Duration</b>	<b>PG – 2 YEARS</b>
<b>Programme Outcomes (POs)</b>	<p><b>PO1: Problem Solving Skill</b> Apply knowledge of Management theories and Human Resource practices to solve business problems through research in Global context.</p> <p><b>PO2: Decision Making Skill</b> Foster analytical and critical thinking abilities for data-based decision-making.</p> <p><b>PO3: Ethical Value</b> Ability to incorporate quality, ethical and legal value-based perspectives to all organizational activities.</p> <p><b>PO4: Communication Skill</b> Ability to develop communication, managerial and interpersonal skills.</p> <p><b>PO5: Individual and Team Leadership Skill</b> Capability to lead themselves and the team to achieve organizational goals.</p> <p><b>PO6: Employability Skill</b> Inculcate contemporary business practices to enhance employability skills in the competitive environment.</p> <p><b>PO7: Entrepreneurial Skill</b> Equip with skills and competencies to become an entrepreneur.</p> <p><b>PO8: Contribution to Society</b> Succeed in career endeavors and contribute significantly to society.</p>

	<p><b>PO 9 Multicultural competence</b></p> <p>Possess knowledge of the values and beliefs of multiple cultures and a global perspective</p> <p><b>PO 10: Moral and ethical awareness/reasoning</b></p> <p>Ability to embrace moral/ethical values in conducting one’s life.</p>
<p><b>Programme Specific Outcomes (PSOs)</b></p>	<p><b>PSO1 – Placement</b></p> <p>To prepare the students who will demonstrate respectful engagement with others’ ideas, behaviors, beliefs and apply diverse frames of reference to decisions and actions.</p> <p><b>PSO 2 - Entrepreneur</b></p> <p>To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate startups and high potential organizations.</p> <p><b>PSO3 – Research and Development</b></p> <p>Design and implement HR systems and practices grounded in research that comply with employment laws, leading the organization towards growth and development.</p> <p><b>PSO4 – Contribution to Business World</b></p> <p>To produce employable, ethical and innovative professionals to sustain in the dynamic business world.</p> <p><b>PSO 5 – Contribution to the Society</b></p> <p>To contribute to the development of the society by collaborating with stakeholders for mutual benefit.</p>

**M.Sc. Biotechnology Programme structure, course work contact hours, credits and maximum internal and external marks for the students admitted in 2023 – 24 onwards**

Course Components	Course Code	Title of Course work	Inst. Hrs/Wk	Credits	Exam Hrs	Marks		Total Marks
						Int	Ext	
<b>SEMESTER - I</b>								
Core paper- 1	23UPBIT1C01	Biochemistry	7	5	3	25	75	100
Core paper - 2	23UPBIT1C02	Molecular Genetics	7	5	3	25	75	100
Practical I	23UPBIT1L01	Practical – I: Biochemistry and Molecular Genetics	6	4	6	40	60	100
Elective Paper -1 Discipline Centric	23UPBIT1E01	Bioinstrumentation	5	3	3	25	75	100
Elective Paper -2 Generic	23UPBIT1E02	Enzymology	5	3	3	25	75	100
<b>Total</b>			<b>30</b>	<b>20</b>	<b>--</b>	<b>--</b>	<b>--</b>	<b>500</b>
<b>SEMESTER - II</b>								
Core Paper-3	23UPBIT1C03	Microbiology	5	5	3	25	75	100
Core Paper-4	23UPBIT1C04	Plant and Animal Biotechnology	5	5	3	25	75	100
Practical II	23UPBIT1L02	Practical – II Microbiology and Plant and Animal Biotechnology	6	4	6	40	60	100
Elective Paper -3/ Discipline Centric	23UPBIT1E03/ 23UPBIT1E04	Regulatory Affairs and Industrial Standards / Pharmaceutical Biotechnology	3	3	3	25	75	100
Elective Paper -5 Generic Elective	23UPBIT1E05	Environmental Biotechnology	3	3	3	25	75	100
NME-I	23UPBIT1N01	MOOC	4	2	3	25	75	100
Skill Enhancement Course -I	23UPBIT1S01	Team Project	4	2	3	40	60	100
Compulsory Paper	23UPPGC1H01	Human Rights	-	1	3	25	75	100
<b>Total</b>			<b>30</b>	<b>25</b>	<b>--</b>	<b>--</b>	<b>--</b>	<b>800</b>
<b>SEMESTER - III</b>								
Core Paper-5	23UPBIT1C05	Bioinformatics	5	5	3	25	75	100
Core Paper-6	23UPBIT1C06	Immunology	5	5	3	25	75	100
Core Paper -7	23UPBIT1C07	Bioprocess Technology	5	5	3	25	75	100
Practical III	23UPBIT1L03	Practical – III Bioinformatics, Immunology	6	4	6	40	60	100

		and Bioprocess Technology						
Elective Paper -6/ Elective Paper -7 Discipline Centric	23UPBIT1E06/ 23UPBIT1E07	Nano Biotechnology / Molecular Developmental Biology	3	3	3	25	75	100
Internship/ Industrial Activity	23UPBIT1I01	Internship in Industries to Biotechnology Field (food / clinical trial/ dairy/ aquasciences, pharmaceutical) CSIR/DBT/ DST research laboratories	-	2	-	-	100	100
NME - II	23UPBIT1N02	Herbal Biotechnology	4	2	3	25	75	100
Skill Enhancement Course -II	23UPBIT1S02	Mini Project	2	2	3	--	100	100
<b>Total</b>			<b>30</b>	<b>28</b>	<b>--</b>	<b>--</b>	<b>--</b>	<b>800</b>
<b>SEMESTER - IV</b>								
Core Paper-8	23UPBIT1C08	Research Methodology	6	5	3	25	75	100
Project - 1	23UPBIT1P01	Dissertation/ Project with Viva-voce	18	8	--	60	240 (40-work book, 150 Dissertat ion +50- Viva)	300
Elective Paper-8/ Elective Paper-9	23UPBIT1E08/ 23UPBIT1E09	Stem Cell Biology/ Bioethics, Biosafety, Clinical Trials, IPR & Entrepreneurship	4	3	3	25	75	100
Skill Enhancement Course -III	23UPBIT1S03	Entrepreneurship in Biotechnology	2	2	3	--	100	100
Extension Activity	23UPBIT1X01		-	1		-	--	--
<b>Total</b>			<b>30</b>	<b>19</b>	<b>--</b>	<b>--</b>	<b>--</b>	<b>600</b>
<b>Final Total</b>			<b>--</b>	<b>92</b>	<b>--</b>	<b>--</b>	<b>--</b>	<b>2700</b>

#### **PATTERN OF QUESTIONPAPER**

QuestionpaperpatternforM.ScBiotechnologydegreecourseforeach semesterwillbegivenasfollows.

For Theory Paper subjects

Part A (20 x 1 = 20 marks)

20 Objectivequestionscoveringallunitsofthe syllabus

Part B (3 x 5 = 15marks)

3Paragraphquestionsof5markstobeansweredchoosingany three out of five. Open choice pattern.

Part C (5 x 8 = 40marks)

5 Paragraph questions of 8 marks to be answered choosing one each from each unit following either/or pattern

**The following procedure is followed for Internal Marks:**

**Theory Papers**

**Internal : 25 Marks**

Best two internal assessments out of 3	10 marks
Attendance	5 marks
Seminar	5 marks
Assignment	5 marks
<b>Total</b>	<b>25 marks</b>

**Practical**

**Internal : 40 Marks**

Practical Tests 2 out of 3	20 marks
Practical Observation Note	5 marks
Attendance	5 marks
Record	5 marks
Viva-voce	5 marks
<b>Total</b>	<b>40 marks</b>

**Break-up Details for Attendance**

Category	Marks
Below 60%	No marks
60% to 75%	3 marks
76% to 90%	4 marks
91% to 100%	5 marks

**Core Paper-1**

**BIOCHEMISTRY**

<b>Paper – 1</b>				
Title of the paper	BIOCHEMISTRY		Subject code: <b>23UPBITC01</b>	
Category of the course	Year	Semester	Credits	Hours
Core Paper	I	I	5	7

**Learning Outcome:**

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-1 | BIOCHEMISTRY**

Unit	Content	Hours	COs	Cognitive level
I	pH, pK . Acid, base. Buffers- Henderson- Haselbach 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	10	CO1	K1&k2
II	Lipids: Nomenclature, classification, structure, chemical and physical properties of fatty acids. Metabolisms: biosynthesis of fatty acids, triglycerols, phospholipids, glycol lipids. Cholesterol biosynthesis, bile acids and salt formation. Eicosanoids, sphingolipids and steroid hormones.	10	CO2	K1,K2& K3
III	Bioenergetics – Concept of energy, Principle of thermodynamics, Relationship between standard free energy and Equilibrium constant, ATP ads 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 $\beta$ -oxidation, alpha and beta oxidation, oxidation of unsaturated and odd chain fatty acids, ketone bodies. Photosynthesis, urea cycle, hormonal regulation of fatty acids and carbohydrates metabolisms, Mineral metabolism	10	CO3	K1,K2& K3
IV	Amino acids and Protein: Nomenclature, Classification, structure, chemical and physical properties of amino acids and proteins. Metabolisms: Biosynthesis of amino acids. Degradation of proteins,	10	CO4	K1,K2& K3

	nitrogen metabolisms and carbon skeleton of amino acids. Over all in born error metabolisms			
V	Nucleic acids: Nomenclature, Classification, structure, chemical and physical properties of purine and pyrimidines. In de novo and salvage synthesis of purines, pyrimidine bases, nucleosides and nucleotides. Catabolisms of purines and pyrimidines bases. Synthetic analogues of nitrogenous bases	10	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, LubertStryer, 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](http://mcdb-webarchive.mcdb.ucsb.edu/.../biochemistry/.../website-tourf.htm)
- [www.biochemweb.org/](http://www.biochemweb.org/)
- <http://golgi.harvard.edu/biopages.html>
- [webarchive.mcdb.ucsb.edu/sears/biochemistry/info/website-](http://webarchive.mcdb.ucsb.edu/sears/biochemistry/info/website-)

**Core Paper-2**  
**MOLECULAR GENETICS**

<b>Paper – 1</b>				
Title of the paper	MOLECULAR GENETICS		Subject code: <b>23UPBIT1C02</b>	
Category of the course	Year	Semester	Credits	Hours
Core Paper	I	I	5	7

**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-2 | MOLECULAR GENETICS**

Unit	Content	Hours	COs	Cognitive level
<b>I</b>	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	10	CO1	K1,K2& K3
<b>II</b>	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	10	CO2	K1,K2&K3
<b>III</b>	DNA Damage and Repair-Internal and external agents causing DNA damages 3.2. DNA damages (Oxidative damages, Depurinations, Depyrimidinations, O6-methylguanines, Cytosine deamination, single and double strand breaks) 3.3. Mechanisms of DNA damage (transition, transversion, frameshift, nonsense mutations) 3.4. Repair mechanisms (Photo reactivation, excision repair, mismatch repair, post replication repair, SOS repair) 3.5. Discovery: Early experiments of McClintock in maize. Insertion sequences in prokaryotes. Complex transposons (ex. Tn3, Tn5, Tn9 and Tn10). Mechanisms, control consequences and application of transposition by simple and complex elements	10	CO3	K1,K2&K3
<b>IV</b>	Allele frequencies and genotype frequencies, Random mating population, Hardy-Weinberg principle,	10	CO4	K1 &K2

	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, Genetics of eukaryotes gene linkage and chromosome mapping.			
V	Extrachromosomal heredity: Biology of Plasmids, their discovery, types and structure of F.RTH. <i>col</i> 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.	10	CO5	K1,K2& K3

**References:**

- Principles of Genetics- 8<sup>th</sup> Edition, Gardner, Simmons and Snustad, 2002.
- The Cell- A Molecular Approach. 3<sup>rd</sup> 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. 4<sup>th</sup> edition. McGraw Hill.
- Leland Hartwell,Leroy Hood, Michael Goldberg, Ann Reynolds, Lee Silver,2010.Genetics: From Genes to Genomes, 4<sup>th</sup> 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, 4<sup>th</sup> 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

**PRACTICAL-I**

**Biochemistry and Molecular Genetics**

Practical-I				
Title of the paper	PRACTICAL-I Biochemistry and Molecular Genetics		Subject code: <b>23UPBIT1L01</b>	
Category of the course	Year	Semester	Credits	Hours
Practical	I	I	4	6

**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   PRACTICALS   PRACTICAL-I				
Unit	Content	Hours	COs	Cognitive level
A	<p><b>(A) Biochemistry - Practical</b></p> <p><b>Major</b></p> <p>1a. Extraction of Proteins from biological materials</p> <p>1b. Protein separation methods:-Ammonium sulphate Precipitation,</p> <p>1c. Membrane Dialysis,</p> <p>1d. SDS PAGE</p> <p>2. Urea-SDS PAGE for separation of low molecular weight proteins</p> <p>3. Estimation of Proteins by Lowry's method</p> <p>4. Estimation of Proteins by Biuret method</p> <p>5. Estimation of Proteins by Bradford method</p> <p>6. Estimation of RNA by orcinol method</p> <p>7. Estimation of DNA by diphenylamine method</p> <p>8. Estimation of Carbohydrate by Anthrone method</p> <p>9. Purity check of DNA &amp; RNA by UV Spectrophotometry - A260/280</p> <p>10. Thermal Denaturation of DNA and UV absorption studies.</p> <p><b>Minor Experiments</b></p> <p>1. Basic calculations in Biochemistry - Normality, Molarity, Molality percent solutions (v/v, w/v).</p> <p>2. Calibration of pH meter</p> <p>3. Transition interval of commonly used pH indicators</p> <p>4. Preparation of biological buffer - phosphate buffer</p> <p>5. Separation of amino acids by Paper Chromatography</p> <p>6. Separation of sugars by Paper Chromatography</p> <p>7. Separation of amino acids by Thin layer chromatography</p> <p>8. Separation of sugars by Thin layer chromatography</p> <p><b>Demo Experiments</b></p> <p>1. Gel permeation chromatography,</p> <p>2. Affinity chromatography,</p>	15	CO1 CO2 CO3 CO4 CO5	K3 & K4

	3. Ion. Exchange chromatography 4. Western blotting 5. PCR			
<b>B</b>	<p align="center"><b>(B) Molecular Genetics - Practical</b></p> <p align="center"><b>Major</b></p> <ol style="list-style-type: none"> <li>Agarose gel electrophoresis of DNA</li> <li>Transfer of DNA from gel – Southern Blotting</li> <li>Isolation of RNA</li> <li>Glyoxal denatured Agarose gel electrophoresis of RNA</li> <li>Formaldehyde denatured Agarose gel electrophoresis of RNA</li> <li>Urea denatured Agarose gel electrophoresis of RNA</li> <li>Transfer of RNA from gel – Northern Blotting</li> <li>Restriction digestion of DNA</li> <li>Giant chromosome studies in Chironomous larvae</li> <li>Cell counting and cell viability;</li> <li>Meiotic study in flower bud sand cockroach or grasshopper.</li> <li>Subcellular fractionation and marker enzyme detection (mitochondria).</li> <li>Preparation of single cell suspension from spleen and thymus.</li> </ol> <p><b>Minor</b></p> <ol style="list-style-type: none"> <li>Isolation of DNA from bacteria.</li> <li>Isolation of DNA from plants.</li> <li>Isolation of DNA from animal tissue.</li> <li>Isolation of DNA from blood.</li> <li>Plasmid DNA isolation.</li> <li>Radiation induced genetic damage assessment.</li> <li>Chemical induced genetic damage assessment.</li> <li>Preparation of metaphase chromosomes form blood.</li> <li>Histochemical staining to localize proteins</li> <li>Histochemical staining to localize carbohydrates</li> <li>Histochemical staining to localize lipids.</li> </ol>	15	CO1 CO2 CO3 CO4 CO5	K3,K4 &K5

### Elective Paper-1

#### BIOINSTRUMENTATION

Elective Paper – 1				
Title of the paper	BIOINSTRUMENTATION		Subject code: <b>23UPBIT1E01</b>	
Category of the course	Year	Semester	Credits	Hours
Elective Paper	I	I	3	5

**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

<b>SYLLABUS   Elective Paper-1   BIOINSTRUMENTATION</b>				
<b>Unit</b>	<b>Content</b>	<b>Hours</b>	<b>COs</b>	<b>Cognitive level</b>
<b>I</b>	Microscopic Techniques: Principles and Applications: Compound, Light, Stereo, Phase Contrast, Fluorescent Microscopy, Scanning and Transmission Electron Microscopy, Scanning Electron Microscopy, Atomic Force Microscopy, Confocal Microscopy, FRET and Flow Cytometry.	7	CO1	K1 & K2
<b>II</b>	Centrifugation: pH meter, 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.	7	CO2	K1, K2, K3
<b>III</b>	Electrophoretic Techniques: Principle and Application of Agarose Gel Electrophoresis, 2D-gel Electrophoresis, PAGE- NATIVE & SDS PAGE, Iso-electric Focusing, High resolution Electrophoresis, Immuno Electrophoresis (Immunofixation EP), ELISA, RIA, Southern, Northern and Western Blotting. Electro blotting, PCR and RT-PCR, Microarray (DNA, Proteins)	7	CO3	K1, K2 & K3
<b>IV</b>	Spectroscopic Techniques: Theory and Application of UV and Visible Spectroscopy, Fluorescence Spectroscopy, Mass Spectroscopy, IR Spectroscopy NMR, ESR, Atomic Absorption Spectroscopy, X- ray Spectroscopy, Laser Spectroscopy and Raman Spectroscopy	7	CO4	K1, K2 & K3
<b>V</b>	Radio-isotopic Techniques: Introduction to Radioisotopes, Uses and their Biological Applications, Radioactive Decay – Types and Measurement , Principles and Applications of GM Counter, Solid and Liquid Scintillation Counter, Autoradiography, RIA,	7	CO5	K1, K2 & K3

Radiation Dosimetry, Health effects of Radiations.			
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**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
- Jeffrey. M., Backer et 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 Paper-2**

**ENZYMOLGY**

Elective Paper – 2				
Title of the paper	ENZYMOLGY		Subject code: 23UPBIT1E02	
Category of the course	Year	Semester	Credits	Hours
Elective Paper	I	I	3	5

**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-2 | 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	7	CO1 CO5	K3 & K5

	electrophoresis and liquid-liquid extraction methods			
<b>II</b>	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, Hanes wolf equation, Eadie hoofstee equation ,Inhibition of enzyme activity	7	CO1 CO2 CO5	K3 & K5
<b>III</b>	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, concerted acid - base catalysis, nucleophilic and electrophilic attacks, catalysis by distortion, metal ion catalysis	7	CO1 CO3	K3 & K4
<b>IV</b>	Theories on mechanism of catalysis.-Mechanism of enzymes action: mechanism of action of lysozyme, chymotrypsin, carboxypeptidase and DNA polymerase. Multienzymes system, Mechanism of action and regulation of pyruvate dehydrogenase and fatty acid synthetase complex	7	CO1 CO4	K3, K4 & K6
<b>V</b>	Coenzyme action. Enzyme regulation: General mechanisms of enzyme regulation, Allosteric enzymes, sigmoidal kinetics and their physiological significance, Symmetric and sequential modes for action of allosteric enzymes. Reversible and irreversible covalent modification of enzymes, Immobilized enzymes and their industrial applications. Clinical and industrial applications of enzymes, Enzyme Engineering	7	CO1 CO5	K3, K4, K5 & K6

#### 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/](http://www.lsbu.ac.uk/biology/enztech/)

- [www.lsbu.ac.uk/biology/enzyme/](http://www.lsbu.ac.uk/biology/enzyme/)
- <http://www.aetlted.com/tech/applications.html>

## Semester I Ends

## II SEMESTER

Course Components	Course Code	Title of Course work	Inst. Hrs/Wk	Credits	Exam Hrs	Marks		Total Marks
						Int	Ext	
<b>SEMESTER - II</b>								
Core Paper-3	23UPBIT1C03	Microbiology	5	5	3	25	75	100
Core Paper-4	23UPBIT1C04	Plant and Animal Biotechnology	5	5	3	25	75	100
Practical II	23UPBIT1L02	Practical – II Microbiology and Plant and Animal Biotechnology	6	4	6	40	60	100
Elective Paper -3/	23UPBIT1E03/	Regulatory Affairs and Industrial Standards /	3	3	3	25	75	100
Elective Paper -4 Discipline Centric	23UPBIT1E04	Pharmaceutical Biotechnology						
Elective Paper -5 Generic Elective	23UPBIT1E05	Environmental Biotechnology	3	3	3	25	75	100
NME-I	23UPBIT1N01	MOOC	4	2	3	25	75	100
Skill Enhancement Course –I	23UPBIT1S01	Team Project	4	2	3	40	60	100
Compulsory Paper	23UPPGC1H01	Human Rights	-	1	3	25	75	100
<b>Total</b>			<b>30</b>	<b>25</b>	<b>--</b>	<b>--</b>	<b>--</b>	<b>800</b>

### Core Paper-3 MICROBIOLOGY

Paper – 3				
Title of the paper	MICROBIOLOGY		Subject code: 23UPBIT1C03	
Category of the course	Year	Semester	Credits	Hours
Core Paper	I	II	5	5



**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.

<b>SYLLABUS   Core Paper-3   MICROBIOLOGY</b>				
<b>Unit</b>	<b>Content</b>	<b>Hours</b>	<b>Cos</b>	<b>Cognitive level</b>
<b>I</b>	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	10	CO1 CO2	K1,K2&K3
<b>II</b>	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 – IMViC, 16s rRNA sequencing. Microscopy: principles and applications of Bright field, florescent and Scanning electron microscopes, Microbial growth control: Physical Methods – Heat, Filtration, Low Temperatures, High Pressure, Desiccation, Osmotic Pressure, Radiation; Chemical Methods	10	CO2 CO3 CO5	K2,K3,K5
<b>III</b>	Host microbe interaction and Epidemiology: Human microbiome; Skin, Gastrointestinal tract, Oral cavity, Lung. Symbiotic relationship of microbes: Symbiosis, Mutualism, Parasitism, Commensalism and	10	CO1 CO3 CO4	K1,K2,K3

	endophyte. Epidemiology of microbes: causes, types and transmission of epidemic, endemic and pandemic diseases			
<b>IV</b>	Microbial Diseases: Microbial diseases - General characteristics, pathogenesis, laboratory diagnosis and control measures of Pandemic and Epidemic diseases: Tuberculosis, Leprosy, Cholera, Typhoid, COVID-19, Yellow Fever, Flu, AIDS, Ebola, Zika Virus, Small Pox, Dengue, Chickungunya, Malaria, filariasis, Candidiasis, superficial mycosis	10	CO4 CO5	K4 &K5
<b>V</b>	Agricultural and Environmental Microbiology: Biological nitrogen fixation, free living, symbiotic nitrogen fixation, mechanism of Nitrogen, Biofertilizers- types and applications; Rhizosphere effect. Biogeochemical cycles-Carbon, Nitrogen, Sulphur and Phosphorous; Methanogenic bacteria Extremophiles- 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-4

### PLANT AND ANIMAL BIOTECHNOLOGY

<b>Paper –4</b>				
Title of the paper	PLANT AND ANIMAL BIOTECHNOLOGY		Subject code: <b>23UPBIT1C04</b>	
Category of the course	Year	Semester	Credits	Hours
Core Paper	I	II	5	5

#### 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-4 | PLANT AND ANIMAL BIOTECHNOLOGY

Unit	Content	Hours	COs	Cognitive level
<b>I</b>	Introduction of plant tissue culture, composition of media, Micropropagation, organogenesis, somatic embryogenesis, haploid and triploid 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	10	CO1 CO5	K1,K2&K3
<b>II</b>	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, Linkage analysis, RAPD markers, STS Mirco satellite, SCAR, SSCP, QTL, Map based cloning and Molecular	10	CO1 CO2 CO5	K1,K2& K5

	marker assisted selection.			
III	Animal health disease diagnosis, hybridoma technique, monoclonal antibodies, application of probes for disease diagnosis of existing and emerging animal diseases. Prophylaxis - Vaccines, 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, Slide and coverslip cultures, flask culture, test tube culture techniques, cell synchronization, cryo preservation. Scaling up of animal cell culture, cell line and cloning micromanipulation and cloning, somatic cell cloning. Karyotyping; measuring parameters for growth, measurement of cell death, apoptosis and its determination, cytotoxicity assays	10	CO4 CO5	K2,K3,K4 & K5
V	Nuclear magnetic resonance methods of monitoring cell metabolism culturing animal cells in fluidised bed reactors. Application of animal cell culture for in vitro testing of drugs, in production of human and animal viral vaccines and pharmaceutical proteins. Culture Scale up and mass production of biologically important compounds. Harvesting of products, purification and assays. 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.Witkowski 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

## PRACTICAL-II

### Microbiology & Plant and Animal Biotechnology

PRACTICAL-II				
Title of the paper	PRACTICAL-II Microbiology & Plant and Animal Biotechnology		Subject code: <b>23UPBIT1L02</b>	
Category of the course	Year	Semester	Credits	Hours
Practical	I	II	4	6

#### 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   PRACTICALS   PRACTICAL-II				
Unit	Content	Hours	COs	Cognitive level
A	<p><b>(A) Microbiology-Practical</b></p> <ol style="list-style-type: none"> <li>1. Sterilization of glassware using dry heat- hot air oven</li> <li>2. Sterilization of media using moist heat – autoclave</li> <li>3. Filter sterilization</li> <li>4. Liquid media preparation – nutrient broth</li> <li>5. Solid media preparation – SDA plates</li> <li>6. Preparation of Agar slants</li> <li>7. Streak plate method</li> <li>8. Pour plate method</li> <li>9. Spread plate method</li> <li>10. Enumeration of total count of the bacteria</li> <li>10. 11. Isolation of microbes from soil</li> <li>12. Isolation of microbes from water</li> <li>13. Isolation of microbes from air</li> <li>14. Isolation of microbes from plant surface.</li> <li>15. Isolation of pure culture of E.coli,</li> <li>16. Isolation of pure culture of Aspergillus niger,</li> </ol>	15	CO1 CO2 CO3 CO4 CO5	K,,K2,K3,K4,K5 &K6

	<p>17. Isolation of pure culture of Streptomyces.</p> <p>18. Gram staining and morphological characterization of microbes.</p> <p>19. Negative staining of bacteria</p> <p>20. Determination of growth curve of bacteria – E.coli</p> <p>21. IMViC test of enteric bacteria</p> <p><b>Demonstration</b></p> <p>16srRNA sequencing</p>			
<b>B</b>	<p><b>(B) Plant and Animal Biotechnology - Practical:</b></p> <p>1. Plant tissue culture media preparation</p> <p>2. Plant tissue culture sterilization techniques.</p> <p>3. Generation of Callus from leaf</p> <p>4. Generation of Callus from root</p> <p>5. Generation of Callus from bud</p> <p>6. Generation of Callus from shoot apex</p> <p>7. Maintenance of callus culture.</p> <p>8. Cell suspension culture</p> <p>9. Anther culture</p> <p>10. Pollen culture</p> <p>11. Embryo culture.</p> <p>12. Isolation of plant protoplast</p> <p>13. Culture of plant protoplast.</p> <p>14. Protoplast viability test.</p> <p>15. Localization of nucleus using nuclear stain.</p> <p>16. Agrobacterium culture maintenance and isolation of plasmid DNA.</p> <p>17. Mass culture of Chlorella /Spirulina</p> <p>18. Introduction to Animal Cell culture: Procedure for handling cells and medium.</p> <p>19. Cleaning and sterilization of glassware and plastic tissue culture flasks</p> <p>20. Preparation of tissue culture media</p> <p>21. Preparation of sera for animal cell culture</p> <p>22. Preparation of single cell suspension from chicken liver (Primary cell culture).</p> <p>23. Trypsinization of established cell culture.</p> <p>24. Cell counting and viability - staining of cells (a) Vital Staining (Trypan blue, Erythrosin (b) Giemsa staining.</p> <p>25. MTT Assay</p>	15	<p>CO1</p> <p>CO2</p> <p>CO3</p> <p>CO4</p> <p>CO5</p>	K3,K4 & K5

### Elective Paper-3

#### REGULATORY AFFAIRS AND INDUSTRIAL STANDARDS

Elective Paper – 3				
Title of the paper	REGULATORY AFFAIRS AND INDUSTRIAL STANDARDS		Subject code: <b>23UPBIT1E03</b>	
Category of the course	Year	Semester	Credits	Hours
Elective Paper	I	II	3	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-3 | REGULATORY AFFAIRS AND INDUSTRIAL STANDARDS

Unit	Content	Hours	COs	Cognitive level
<b>I</b>	<p><b>Planning, Organisation and setting of Food testing laboratory and laboratory safety</b></p> <p>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, pre-requisites for accreditation, management requirements, technical requirements, measurement of traceability, Laboratory safety: Personnel and laboratory hygiene, emergency planning, general hazards in a food laboratory, safety</p>	7	CO1	K2,K3,K4

	equipment, storage of chemicals, acids, flammables etc, handling and biological spills and waste disposal.			
<b>II</b>	<p><b>Principles of Food Preservation technology</b></p> <p>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 &amp; Class-II preservatives, smoke other chemical additives, New non-thermal methods: High hydrostatic pressure, modified atmosphere, high intensity pulsed electric fields, intense pulsed light, oscillating magnetic fields, hurdle technology, ultrasonic and ohmic heating etc.</p>	10	CO2	K2 & K3
<b>III</b>	<p><b>Principles of Food Packaging technology</b></p> <p>Effect of environment on food stability: light, oxygen, water, temperature, sensitivity to mechanical damage and attack by biological agents, Different packaging materials used for food packaging and their properties including barrier properties, strength properties, optical 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 smart and intelligent packaging, Newer packaging technologies-CAP/MAP packaging aseptic processing and packaging, irradiated packaging, retort pouch and microwaveable packaging.</p>	10	CO3	K2, K3 & K4
<b>IV</b>	<p><b>Food Microbiology and testing</b></p> <p>Introduction of Food microbiology: Classification and nomenclature of microorganisms. Morphology and structure of microorganisms in foods (yeast and Molds, Bacterial cells viruses), Important genera of mold, yeast, bacteria (Gram positive and Gram negative, facultative aerobic and anaerobic, endospore forming bacteria and non-sporulating bacteria), Bacterial groups (lactic acid, acetic acid, butyric acid</p>	10	CO4	K2, K3, K4



	<p>etc.), thermophilic, proteolytic, saccharomycitetc, coliforms, faecal coliforms, enteric pathogens and emerging microbes, Sources of microorganisms in food chain (raw materials, water, air, equipment etc) and microbiological quality of foods, Microbial growth characteristics: Reproduction and growth (fission, generation time optimum growth, growth curve etc). 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, D Value, Z-Value, F-Value, thermal death time curve, 12 D Concept, Microbial food spoilage and food borne diseases, food pathogens, <i>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.</i>, 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.</p>			
V	<p><b>HACCP and Food safety management systems:</b>  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.</p>	7	CO5	K2,K3 & K6
<p><b>References:</b></p> <ul style="list-style-type: none"> <li>• ISO 9001, Quality management systems – Requirements</li> <li>• ISO 17034 General requirements for the competence of reference material producers</li> <li>• ISO/IEC 17043 Conformity assessment – General requirements for proficiency testing.</li> </ul>				

- Food safety standards authority regulation 2011.

### Elective Paper-4

## PHARMACEUTICAL BIOTECHNOLOGY

Elective Paper-4				
Title of the paper	PHARMACEUTICAL BIOTECHNOLOGY		Subject code: 23UPBIT1E04	
Category of the course	Year	Semester	Credits	Hours
Elective Paper	I	II	3	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-4 | 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.	7	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, Recombinant DNA technology, Application of rDNA technology and genetic engineering in the production of: (i) Interferon (ii) Vaccines - hepatitis- B (iii)	7	CO2	K3 & K4

	Hormones – Insulin, Brief introduction to Protein Engineering, Therapeutic proteins, Production of Enzymes- General consideration – Amylase, Catalase, Peroxidase, Lipase, Protease, Penicillinase, Methods of enzyme immobilization and applications			
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 and Griseofulvin Somatic gene therapy, Xenotransplantation in pharmaceutical biotechnology, Large scale production fermenter design and its various controls, Bio safety in pharmaceutical industry	7	CO3	K2
IV	Pharmacological activity of Plant drugs, Plant Chemicals in modern pharmacology; biochemistry and pharmacology of atropine, caffeine, ephedrine, opioids, taxol, vinca alkaloids, synthetic substitutes for therapeutically active plant constituents; drug improvement by structure modification and bio-transformation. Criteria for pharmacological evaluation of drugs.	7	CO4	K2 & K4
V	Clinical Pharmacology, Drug therapy, therapeutic situation, benefits and risk of use of drugs, 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.	7	CO5	K1,K2&K5

**Reference Books:**

- Harbanslal, 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. Corpenner (editor), Mark C. Manning. 2002. Rational Design of stable formulation Theory and Practice (Pharmaceutical Biotechnology). Plenum, US. 1st 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-5**

**ENVIRONMENTAL BIOTECHNOLOGY**

<b>Elective Paper – 5</b>				
Title of the paper	ENVIRONMENTAL BIOTECHNOLOGY		Subject code: 23MBTE05	
Category of the course	Year	Semester	Credits	Hours
Elective Paper	I	II	3	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-5 | ENVIRONMENTAL BIOTECHNOLOGY**

<b>Unit</b>	<b>Content</b>	<b>Hours</b>	<b>COs</b>	<b>Cognitive level</b>
<b>I</b>	Environment: Basic concepts and issues; Environmental management and Conservation, Environmental Laws & Agencies involved in conservation. Environmental Pollution: Types of	7	CO1 CO5	K2

	pollution & its control strategies -Air pollution, Soil pollution, Water pollution, Oil pollution & Radioactive pollution			
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	7	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.	7	CO3	K4
IV	Toxicity: Types and Test for evaluating Toxicity. Biosensors, Biomonitoring of toxic materials .Biomagnification, Biomining and Biofuels	7	CO4	K5
V	Bioremediation: <i>In-situ and Ex-situ</i> 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.	7	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:**

- [lbwww.epfl.ch/LBE/Default\\_E.htm](http://lbwww.epfl.ch/LBE/Default_E.htm)
- <http://lbe.epfl.ch>

**Extra disciplinary subject for other Department students (NME)**

**MOOC**

<b>NME Paper – 1</b>				
Title of the paper	MOOC		Subject code: <b>23UPBIT1N01</b>	
Category of the course	Year	Semester	Credits	Hours
Extra disciplinary subject	I	II	2	4

<b>SKILL EHNANCEMENT COURSE (SEC - 1) PAPER – 1</b>				
Title of the paper	Team Project		Subject code: <b>23UPBIT1S01</b>	
Category of the course	Year	Semester	Credits	Hours
Skill enhancement course	I	II	2	4

<b>Compulsory Paper</b>				
Title of the paper	Human Rights		Subject code: <b>23UPPGC1H01</b>	
Category of the course	Year	Semester	Credits	
Compulsory Course	I	II	1	

**II SEMESTER END**

**III SEMESTER**

Course Components	Course Code	Title of Course work	Inst. Hrs/Wk	Credits	Exam Hrs	Marks		Total Marks
						Int	Ext	
<b>SEMESTER – III</b>								
Core Paper-5	23UPBIT1C05	Bioinformatics	5	5	3	25	75	100
Core Paper-6	23UPBIT1C06	Immunology	5	5	3	25	75	100
Core Paper -7	23UPBIT1C07	Bioprocess Technology	5	5	3	25	75	100
Practical III	23UPBIT1L03	Practical – III Bioinformatics, Immunology and BioprocessTechnology	6	4	6	40	60	100

Elective Paper - 6/ Elective Paper -7 Discipline Centric	23UPBIT1E06/ 23UPBIT1E07	Nano Biotechnology / Molecular Developmental Biology	5	3	3	25	75	100
Internship/ Industrial Activity	23UPBIT1I01	Internship in Industries to Biotechnology Field (food / clinical trial/ dairy/ aquasciences, pharmaceutical) CSIR/DBT/ DST research laboratories	-	2	6	-	100	100
NME – II	23UPBIT1N02	Gene Manipulation Technology	4	2	3	25	75	100
Skill Enhancement Course -II	23UPBIT1S02	Mini Project	2	2	3	--	100	100
<b>Total</b>			<b>30</b>	<b>28</b>	<b>--</b>	<b>--</b>	<b>--</b>	<b>800</b>

**Core Paper-5**  
**BIOINFORMATICS**

<b>Core Paper-5</b>				
Title of the paper	BIOINFORMATICS		Subject code: <b>23UPBIT1C05</b>	
Category of the course	Year	Semester	Credits	Hours
Core Paper	II	III	5	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

<b>SYLLABUS   Core Paper-5   BIOINFORMATICS</b>				
<b>Unit</b>	<b>Content</b>	<b>Hours</b>	<b>COs</b>	<b>Cognitive level</b>
<b>I</b>	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), Big data analysis - DNA/RNA/protein sequence or structure data, gene expression data, protein-protein interaction (PPI) data, pathway data and gene ontology (GO) data	10	CO1	K1 & K2
<b>II</b>	Sequence alignment basics, match, mismatch, similarity, scoring an alignment, gap penalty, protein vs DNA alignments, Dot-matrix alignment, pairwise alignment. 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 (Smith and Waterman) and Heuristic algorithms (FASTA and Blast). Multiple sequence alignment based database searching. PSI- Blast, PAM and Blosun matrices	10	CO2	K2,K3 & K5
<b>III</b>	Bioinformatics for genome sequencing, EST Clustering and analyses, Finding genes in prokaryotic and eukaryotic genomes, Regulatory sequence analysis, Bioinformatics for Genome maps and markers, Bioinformatics for understanding Genome variation, Protein structure-X-ray crystallography, The protein databank and the PDBSum-SCOP,	10	CO3	K2 & K5



	CATH, DALI and HSSP ;Visualization of molecular structures-RasMol and Pymol; Protein secondary structure prediction, Fold Recognition; Transmembrane topology prediction			
<b>IV</b>	Molecular visualization tools. Rasmol, Chime and Spdb viewer. Structure analysis tools. VAST and DALI, Structural biology - Homology modeling, Bioinformatics for micro array designing and transcriptional profiling, Bioinformatics for metabolic reconstruction, Bioinformatics for phylogenetic analysis	10	CO4	K4 & K5
<b>V</b>	Medical application of Bioinformatics. Disease genes, Drug Discovery. History. Steps in drug discovery. Target Identification. Target Validation. QSAR. Lead Identification. Preclinical pharmacology and toxicology. ADME. Drug designing. Rational drug design. Computer aided drug design. Ligand based approach. Target based approach	10	CO5	K3,K4 & K6

**Reference Books:**

- Dassanayake S.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.
- Bosu Orpita, Simminder Kaur Thukral, 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-6**

**IMMUNOLOGY**

<b>Core Paper-6</b>				
Title of the paper	IMMUNOLOGY		Subject code: <b>23UPBIT1C06</b>	
Category of the course	Year	Semester	Credits	Hours
Core Paper	II	III	5	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

<b>SYLLABUS   Core Paper-6   IMMUNOLOGY</b>				
<b>Unit</b>	<b>Content</b>	<b>Hours</b>	<b>COs</b>	<b>Cognitive level</b>
<b>I</b>	History and overview of the immune system. Types of immunity - innate, acquired, passive and active, self vs non-self-discrimination. Physiology of immune response: HI and CMI specificity and memory. Cells and organs of the immune system .Lymphoid tissue, origin and development. Hematopoiesis and differentiation of lymphocytes	10	CO1	K1 & K2
<b>II</b>	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, adjuvants. Immunoglobulins- structure, distribution and function. Immunoglobulin super family Isotypic, Allotypic and Idiotypic variants, generation of antibody diversity	10	CO2	K2,K3 & K5
<b>III</b>	Monoclonal antibody production and its applications. Types of vaccine and vaccination schedule. Role of MHC antigens in immune responses, Structure and function of class I and class II MHC molecules. MHC antigens in transplantation and HLA tissue typing. Transplantation immunology- immunological basis of graft rejection, cinical transplantation and Immunosuppressive therapy. Tumour Immunology - Tumour antigen, Immune response to tumours	10	CO3	K2 & K5
<b>IV</b>	Effector mechanisms in immunity - macrophage activation, cell mediated cytotoxicity, cytotoxicity	10	CO4	K4 & K5

	assay. Hypersensitivity reactions and types. The complement system, mode of activation, classical and alternate pathway, biological functions of C proteins			
V	Immunotechniques- Principle and Applications: Immunodiffusion, Immuno fluorescence, Insitu localization technique - FISH and GISH. RIA and ELISA, FACS, Western blot, ELISPOT assay. Agglutination tests. VDRL test. Purification of antibodies, Quantitation of immunoglobulin by RID, EID and nephelometry, CMI techniques and Immunotherapy.	10	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 Molecular Immunology. 6th Edition. Saunders Elsevier Publications, Philadelphia.
- Seemi Garhat Bashir, 2009. Text Book of Immunology, PHI Learning Pvt. 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. New Age International, New Delhi.

**Useful Websites:**

- [www.library.csusm.edu/course\\_guides/biology](http://www.library.csusm.edu/course_guides/biology)
- [www.immunologylink.com](http://www.immunologylink.com)
- <http://www.wiley.com/college/bio/karp12791/weblinks.html>

**Core Paper-7**

**BIOPROCESS TECHNOLOGY**

Core Paper-7				
Title of the paper	BIOPROCESS TECHNOLOGY		Subject code: <b>23UPBIT1C07</b>	
Category of the course	Year	Semester	Credits	Hours
Core Paper	II	III	5	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

<b>SYLLABUS   Core Paper-7   BIOPROCESS TECHNOLOGY</b>				
<b>Unit</b>	<b>Content</b>	<b>Hours</b>	<b>COs</b>	<b>Cognitive level</b>
<b>I</b>	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. Food Safety: Introduction to food safety aspects and food related hazards – HACCP and ISO.	10	CO1	K1 & K2
<b>II</b>	Types of bioreactors: Submerged reactors, surface reactors, mechanically agitated reactors, non-mechanically agitated reactors. Design of fermenters, body construction. Production of citric acid, penicillin and insulin. Isolation and improvement of Industrially important Micro-organisms, Media for Industrial fermentation and Sterilization.	10	CO2	K2,K3 & K5
<b>III</b>	Introduction to bioproducts and bioseparation. Primary recovery process: Cell disruption methods. Cell lysis and Flocculation: Osmotic and mechanical methods of lysis. Flocculation by electrolysis; polymorphic flocculation. Precipitation methods. Filtration: Principles, Conventional, Crossflow filtration. Sedimentation: Principles, Sedimentation coefficients. Extraction Principles, Liquid liquid extraction, aqueous two phase extraction, supercritical fluid extraction.	10	CO3	K2 & K5
<b>IV</b>	Down Stream Processing: Chromatography Techniques, Membrane separation, ultrafiltration. Drying .Principles and operation of vacuum dryer, shelf dryer, rotary dryer, freezer and spray dryer. Crystallization and Whole broth processing.	10	CO4	K4 & K5

<b>V</b>	Aerobic and anaerobic fermentation processes and their application in the field of biotechnology industry. Production of commercially important primary and secondary metabolites, Effluent Treatment and Fermentation Economics.	10	CO5	K3,K4 & K6
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**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](http://www.wildfermentation.com/John_Schollar_and_BenedikteWatmore), Practical Fermentation-a technicalguide
- [web.mit.edu/professional/short.../fermentation\\_technology.html](http://web.mit.edu/professional/short.../fermentation_technology.html)

**PRACTICAL-III**

**Bioinformatics, Immunology & Bioprocess Technology**

<b>PRACTICAL</b>				
Title of the paper	PRACTICAL-III Bioinformatics, Immunology & Bioprocess Technology		Subject code: <b>23UPBIT1L03</b>	
Category of the course	Year	Semester	Credits	Hours
Practical	II	III	4	6

**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 | PRACTICALS | PRACTICAL-III**

Unit	Content	Hours	COs	Cognitive level
<b>A</b>	<b>(A) Bioinformatics-practical</b>	15	CO1	K1,K2,K3,K4

	<ol style="list-style-type: none"> <li>1. Sequence retrieval from Genbank</li> <li>2. Sequence retrieval from Uniprot.</li> <li>3. Sequence identity search- Sequence similarity search using BLAST</li> <li>4. Sequence similarity search using FASTA</li> <li>5. Sequence similarity search using PSI BLAST</li> <li>6. Sequence similarity search using PHI- BLAST.</li> <li>7. Prediction of signal sequence using SignalP online tool</li> <li>8. Pattern Search (Domains &amp; Motifs) using Pfam</li> <li>9. ORF gene Search - Genscan</li> <li>10. Sequence translation using ExPASy translate tool</li> <li>11. Characterization of retrieved protein sequence by ProtParam tool.</li> <li>12. Pair-wise global sequence alignment using EBI-EMBOSS Needleman Wunsch tool</li> <li>13. Pair-wise local sequence alignment using EBI-EMBOSS Smith Waterman tool</li> <li>14. Multiple sequence alignment using EBI-CLUSTALW2.</li> <li>15. PHYLOGENY- Phylogenetic tree using PHYLIP.</li> <li>16. Prediction of secondary protein structure using GOR (Garnier Osguthorpe-Robson) server.</li> <li>17. Prediction of tertiary protein structure using SWISS-MODEL Server</li> <li>18. Validation of the predicted structure using PROCHECK server</li> <li>19. Molecular visualization of proteins using RASMOL.</li> <li>20. Docking of small molecule with protein structure using Hex software.</li> <li>21. Docking of two proteins using PatchDock (Protein-Protein docking) tool.</li> <li>22. Retrieval of E.Coli glycolytic pathway from KEGG</li> </ol>		<p>CO2</p> <p>CO3</p> <p>CO4</p> <p>CO5</p>	&K5
<b>B</b>	<p><b>(B) Immunology - practical</b></p> <ol style="list-style-type: none"> <li>1. Identification of various immune cells from human peripheral blood.</li> <li>2. Lymphocyte separation and identification</li> <li>3. Determination of lymphocyte viability by trypan blue method</li> <li>4. WBC counting</li> <li>5. Preparation of serum and plasma</li> <li>6. Electrophoretic profile of human serum in native PAGE</li> <li>7. Preparation of cellular antigen – human RBC</li> <li>8. Preparation of antigen-adjuvant mixture for production of polyclonal antibody</li> <li>9. Isolation of IgG molecule from serum</li> </ol>	15	<p>CO1</p> <p>CO2</p> <p>CO3</p> <p>CO4</p> <p>CO5</p>	K2,K3,K4

	10. Immunodiagnosics: CRP 11. Immunodiagnosics: ASO 12. Immunodiagnosics: Widal 13. Immunodiagnosics: RA 14. Immunodiagnosics: Blood grouping and typing 15. Immunodiagnosics: hCG 16. ELISA 17. Radial Immunodiffusion 18. Ouchterlony Immunodiffusion 19. Immunoelectrophoresis 20. Rocket electrophoresis 21. Counter current immunoelectrophoresis. 22. Bioassays for cytokines 23. Radioimmunoassays (Demonstration)			
<b>C</b>	<b>(C) Bioprocess Technology - Practical</b> 1. Parts and design of fermenter 2. Solid state fermentation 3. Submerged fermentation 4. Foaming and antifoaming agents 5. Media preparation and sterilization 6. Isolation of industrially important microorganisms for microbial processes. 7. Conservation of Bacteria by Lyophilization. 8. Production and estimation of protease 9. Production and estimation of amylase. 10. Production of wine using grapes 11. Production of penicillin 12. Determination of penicillin activity 13. Citric acid production 14. Use of alginate for cell immobilization. 15. Media standardization (C:N ratio) for maximum biomass production of an industrially important microorganism. 16. Cell disruption (Sonication) 17. Aqueous Two Phase Extraction of enzymes	15	CO1 CO2 CO3 CO4 CO5	K2,K3,K4 & K5

**Elective Paper-6**

**NANO BIOTECHNOLOGY**

<b>Elective Paper-6</b>				
Title of the paper	NANO BIOTECHNOLOGY		Subject code: <b>23UPBIT1E06</b>	
Category of the course	Year	Semester	Credits	Hours
Elective Paper	II	III	3	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

<b>SYLLABUS   Elective Paper-6   NANO BIOTECHNOLOGY</b>				
<b>Unit</b>	<b>Content</b>	<b>Hours</b>	<b>COs</b>	<b>Cognitive level</b>
<b>I</b>	Introduction to Nanotechnology- Scientific revolution, Feynman's vision, Classification of nanobiomaterials -Types of nanomaterials – nanoparticles, nanotubes, nanowires, Nanofibers, Size dependent variation in the properties of Nanomaterials, Nature's Nanophenomena.	7	CO1	K1
<b>II</b>	Preparation of Nanomaterials, Top down and bottom up approaches, Biosynthesis, Nanobiomaterials- Polymer, Ceramic, Metal based Nanobiomaterials, Carbon based Nanomaterials, DNA based Nanostructures, Protein based Nanostructures, Quantum dots, Magnetic Nanoparticles, Nanofibres, Hydrogels, Films and Scaffolds.	7	CO2	K4
<b>III</b>	Application of Nanomaterials in Bone substitutes and Dentistry, Food and Cosmetic applications, Bio-sensors and Lab-on-a-chip, Bio-devices and implantable devices, Bioremediation, Nanomaterials for anti-microbial coating – medical implants and paints, Application of Nanotechnology in textile industry.	7	CO3	K1 & K5
<b>IV</b>	Nanomaterials for diagnosis and therapy, Implications of drug delivery, Nano-carriers for application in medicine, polymeric nanoparticles as drug carriers, Drug release mechanism, Targeted Drug Delivery using nanocarriers, Nanoparticle technologies for cancer therapy and diagnosis, Point of Care and Personalized medicine, Magnetic nanoparticles for imaging and Hyperthermia.	7	CO4	K2



V	Nanotoxicology, Portals of Entry of the nanoparticles into the Human Body, Bio-toxicity of Nanoparticles, Nanoparticles in Mammalian systems and Health threats, Biological response and cellular interaction of implant materials and scaffolds, Risk assessment and Safety Regulation of nanoparticles.	7	CO5	K5
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**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.
- ChallaS.S.R.Kumar (Ed). 2006. Biologicals and pharmaceutical nanomaterials, Wiley-VCH Verlag GmbH& Co, KgaA.
- K.K.K.Jain 2006. Nanobiotechnology in Molecular Diagnostics: Current Techniques and Applications Horizon Bioscience
- Niemeyer, C.M., Mirkin, C.A. (Eds). 2004. Nanobiotechnology Concepts, Applications and Perspectives, Wiley-VCH, Weinheim.
- Andrzej 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, Horizons 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, Gurusurthy Ramachandran, Elsevier, 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/](http://www.fda.gov/nanotechnology/) [www.nature.com/nnano/](http://www.nature.com/nnano/)

## Elective Paper-7

### MOLECULAR DEVELOPMENTAL BIOLOGY

Elective Paper-7				
Title of the paper	MOLECULAR DEVELOPMENTAL BIOLOGY		Subject code: <b>23UPBIT1E07</b>	
Category of the course	Year	Semester	Credits	Hours
Elective Paper	II	III	3	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-7 | MOLECULAR DEVELOPMENTAL BIOLOGY

Unit	Content	Hours	COs	Cognitive level
<b>I</b>	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	7	CO1	K1,K2& K5
<b>II</b>	Fertilization - Definition, mechanism of fertilization in mammal & sea urchin. Types of fertilization. Nieuwkoop center, Molecular role of organizer	7	CO2	K4
<b>III</b>	Cleavage in Xenopus, Chick and mammals, Regulation of cleavage cycle. Morphogenetic movements, Gastrulation in Xenopus, Chick and mammals. Fate Maps	7	CO3	K3
<b>IV</b>	Vertebrate Development: Formation of the neural tube, myogenesis, and hematopoiesis. Mechanism of vertebrate eye development	7	CO4	K2
<b>V</b>	Drosophila Maternal effect genes, induction at single	7		K1 & K4

cell level - differentiation of photoreceptors in ommatidia. Developmental disorders Spina bifida, Anencephaly, and craniorachischis, Cyclopia, Thanotrophic dysplasia		CO5	
<b>Reference Books:</b> <ul style="list-style-type: none"> <li>• Scott F.Gilbert, 2010. Developmental Biology, 9th edition, Sinauer Associates Inc.</li> <li>• Subramoniam, T. 2002. Developmental Biology. 1st edition. Narosa publications.</li> <li>• Richard M.Twynman, 2001 Developmental Biology. (2 nd edition), Viva Publications, New Delhi.</li> </ul>			
<b>Useful Websites:</b> <a href="http://sackler.tufts.edu/.../Cell-Molecular-and-Developmental-Biology">sackler.tufts.edu/.../Cell-Molecular-and-Developmental-Biology</a> <a href="http://www.devbio.com/">www.devbio.com/</a>			

### INTERNSHIP/ INDUSTRIAL ACTIVITY

Summer Internship				
Title of the paper	INTERNSHIP	Subject code: <b>23UPBIT1I01</b>		
Category of the course	Year	Semester	Credits	Hours
Paper	II	III	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

**Extra disciplinary subject for other Department students (NME)**

## HERBAL BIOTECHNOLOGY

NME Paper – 2				
Title of the paper	HERBAL TECHNOLOGY		Subject code: <b>23UPBIT1N02</b>	
Category of the course	Year	Semester	Credits	Hours
Extra disciplinary subject	I	II	2	4

### Learning Outcomes:

- Understand the basic principles of traditional system of herbal medicine
- Obtain the knowledge on basics of plant diseases and their control measures using herbals
- Explain the technical aspects of plant biomolecules
- Describe the basics of parasitic diseases and their herbal control measures
- Summarize various forms of human diseases and their treatments using herbal plants

### Course Outcomes:

CO-1	Learn the Indian traditional system of medicine
CO-2	Highlights the molecular methods for plant identification
CO-3	<ul style="list-style-type: none"> <li>• Plant diseases and its control using plant molecules</li> <li>• How to extract the molecules from plants</li> <li>• Use of phytomolecules against parasitic diseases</li> </ul>
CO-4	Role of herbals in controlling/managing most dreadful diseases in humans

### SYLLABUS | NME-II | HERBAL BIOTECHNOLOGY

Unit	Content	Hours	COs	Cognitive level
<b>I</b>	Traditional system of medicine: Ayurveda, Siddha, Unani, and Homeopathy. Plant tissue culture and molecular markers: RAPD, RFLP and AFLP for authentication of medicinal plants.		CO1	K1, K2 & K5
<b>II</b>	Viral diseases: TMV, Bacterial diseases: (Blast, blight), fungal diseases (smelt and wilt). Control measures and use of herbicides.		CO2	K4
<b>III</b>	Herbal extraction methods: Steps, solvents and		CO3	K3

	equipment. Types of herbal extract preparations and storage methods. Plant biomolecules and their future prospects in drug industry.			
IV	Parasitic diseases: Malaria and filaria. Metabolites as potential insecticides. Control of malaria parasite and vector.		CO4	K2
V	Herbs to treat human diseases: Diabetic, cancer, diarrhea, skin and HIV, neurodegenerative disorders		CO5	K1 & K4

**Reference Books:**

- Kiritikar K.R. and Basu, B.D. 1980. Indian medicinal plants Vol. I-V, CSIR Publications, New Delhi.
- Janardhan Reddy, K. 2007. Advances in medicinal plants, University Press
- Sharma, P.D. 2006. Plant Pathology, Alpha Scientific International, India
- Cheng, 1975. Molecular parasitology, Elsevier Publications, London
- Lee Lerner and Brenda Wilmoth, 2007. Biotechnology: Medicine Vol. I, Thomas-Gale Publications, US
- Lee Lerner and Brenda Wilmoth, 2007. Biotechnology: Agriculture Vol. II, Thomas-Gale Publications, US
- Lee Lerner and Brenda Wilmoth, 2007. Biotechnology: Industry Vol. III, Thomas-Gale Publications, US

SKILL ENHANCEMENT COURSE (SEC - II) Paper – 2				
Title of the paper	Mini Project		Subject code: 23UPBIT1S02	
Category of the course	Year	Semester	Credits	Hours
Skill Enhancement Course	II	III	2	2

**III SEMESTER END**

**IV SEMESTER**

Course	Course Code	Title of Course work	L	Hr	edi	m	Marks	a	i	M	e
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Components						Int	Ext	
<b>SEMESTER – IV</b>								
Core Paper-8	23UPBIT1C08	Research Methodology	6	5	3	25	75	100
Project-1	23UPBIT1P01	Dissertation/ Project with Viva-voce	18	8	--	60	240 (40-work book, 150 Dissertation +50-Viva)	300
Elective Paper -6	23UPBIT1E08/ 23UPBIT1EB06	Stem Cell Biology/ Bioethics, Biosafety, Clinical Trials, IPR & Entrepreneurship	4	3	3	25	75	100
Skill Enhancement Course –III	23UPBIT1S03	Entrepreneurship in Biotechnology	2	2	3	--	100	100
Extension Activity	23UPBIT1X01		-	1		-	--	--
<b>Total</b>			<b>30</b>	<b>19</b>	<b>--</b>	<b>--</b>	<b>--</b>	<b>600</b>

### Core Paper-8

#### RESEARCH METHODOLOGY

Core Paper-8			
Title of the paper	RESEARCH METHODOLOGY		Subject code: <b>23UPBIT1C08</b>
Category of the course	Year	Semester	Credits
Core Paper	II	IV	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-8   RESEARCH METHODOLOGY				
Unit	Content	Hours	COs	Cognitive level

I	Research Methodology - An Introduction: Meaning of Research, Objectives of Research, Types of Research, Research Approaches, Importance of knowing how research is done, Research Process, Criteria of good research. Defining the Research Problem; Research Design; Sampling Design; Methods of Data Collection; Processing and Analysis of Data; Sampling Fundamentals	10	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	10	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, Confidence interval; ANOVA for random effects model, Estimation of variance components, Model adequacy checking. Two factor Factorial Design, Basic definitions and principles, main effect and interaction, response surface and contour plots, General arrangement for a two factor factorial design	10	CO3	K3
IV	Spreadsheet Tool: Introduction to spreadsheet application, features and functions, Using formulas and functions, Data storing, Features for Statistical data analysis, Generating charts/ graph and other features. 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	10	CO4	K1 & K4
V	Web Search: Introduction to Internet, Use of Internet and WWW, Using search engine like Google, Yahoo, Pubmed, Science direct, Scopus etc, 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, Appalyer and Mathiranjana 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](http://www.ask.com/Methodology+Research)
- [www.qmethod.org/](http://www.qmethod.org/)

### PROJECT-1

#### DISSERTATION

PROJECT-1				
Title of the paper	DISSERTATION		Subject code: <b>23UPBIT1P01</b>	
Category of the course	Year	Semester	Credits	Hours
Core Paper	2 <sup>nd</sup>	4 <sup>th</sup>	8	18

#### 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.

### Elective Paper-8

#### STEM CELL BIOLOGY

Elective Paper-8			
Title of the paper	STEM CELL BIOLOGY		Subject code: <b>23UPBIT1E08</b>
Category of the course	Year	Semester	Credits
Elective Paper	2	4	3

#### 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-8 | STEM CELL BIOLOGY**

<b>Unit</b>	<b>Content</b>	<b>Hours</b>	<b>COs</b>	<b>Cognitive level</b>
<b>I</b>	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
<b>II</b>	Stem cell niche, Niche specification - Drosophila germ line stem cells. Receptors, genes and markers of stem cells	7	CO2	K1 & K2
<b>III</b>	Stem cell isolation and culture techniques. Characterization of stem cells	7	CO3	K3, K4
<b>IV</b>	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
<b>V</b>	Applications of Embryonic stem cells, Bone marrow stem cells, Adipose derived stem cells and Hematopoietic stem cells. Ethics in human stem cell research	7	CO5	K3,K4 & K5

**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

## Elective Paper-9

### BIOETHICS, BIOSAFETY, CLINICAL TRIALS, IPR & ENTREPRENEURSHIP

Elective Paper-9			
Title of the paper	BIOETHICS, BIOSAFETY, CLINICAL TRIALS, IPR & ENTREPRENEURSHIP	Subject code: 23MBTEB09	
Category of the course	Year	Semester	Credits
Elective Paper	2	4	3

#### 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-9 | 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 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.	10	CO5	K4,K5 & K6

**Reference Books:**

- “Bioethics & Biosafety” by Sateesh MK, IK International publications, 2008
- USPTO Web Patent Databases at: [www.uspto.gov/patft](http://www.uspto.gov/patft)

- Government of India's Patents Website: [patinfo.nic.in](http://patinfo.nic.in)
- Intellectual property India: [www.ipindia.nic.in](http://www.ipindia.nic.in)
- “Indian Patent Law : Legal and Business Implications” by AjitParulekar, 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.
- ErbischF.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.
- EladHarison (2008). Intellectual Property Rights, Innovation and Software Technologies. Edward Elgar Publishing Limited, UK.

SKILL ENHANCEMENT COURSE (SEC - III) Paper – 3				
Title of the paper	EntrepreneurshipinBiotechnology		Subject code: 23UPBIT1S03	
Category of the course	Year	Semester	Credits	Hours
Skill Enhancement Course	II	IV	2	2

**Learning Outcome:**

Students will be able to Gain knowledge in selling their biotechnological innovative ideas. Find problems worth solving in entrepreneurial setup Mobilize people and resources Add value for their innovation by company formation, Social Innovation and Intellectual property Licensing.

**Course Outcome:**

CO-1	Plant tissue culture lab organization- Basic requirements & facilities for functioning and experimentation
CO-2	Micro propagation protocol for various plants – Optimization of Media and Growth hormones. Virus indexing and genetic Fidelity test Certification.
CO-3	Tissue culture contamination and its prevention. Procedure for tissue culture plants hardening. Establishment of hardening units.
CO-4	Biosimilar, Recombinant Proteins, Monoclonal Antibody Production
CO-5	Cell culture, Cell based Assay, Tissue Engineering and Biomaterial, In vitro Diagnostics

SYLLABUS   SKILL EHNANCEMENT COURSE (SEC - III) Paper – 3				
EntrepreneurshipinBiotechnology				
Unit	Content	Hours	COs	Cognitive level

<b>I</b>	Plant tissue culture lab organization- Basic requirements & facilities for functioning and experimentation.	10	CO1	K2,K3 & K4
<b>II</b>	Micro propagation protocol for various plants – Optimization of Media and Growth hormones. Virus indexing and genetic Fidelity test Certification.	10	CO2	K3, K4 & K5
<b>III</b>	Tissue culture contamination and its prevention. Procedure for tissue culture plants hardening. Establishment of hardening units.	10	CO3	K3,K4 & K5
<b>IV</b>	Biosimilar, Recombinant Proteins, Monoclonal Antibody Production.	10	CO4	K4, K5 & K6
<b>V</b>	Cell culture, Cell based Assay, Tissue Engineering and Biomaterial, In vitro Diagnostics.	10	CO5	K4,K5 & K6

**Reference Books:**

1. Robert N Trigiano. 2018. Plant Tissue culture Concepts and laboratory Exercises, CRC Press LLC., USA.
2. Edward Johnson, 2020. Plant Tissue Culture: a Home Based Guide: How to practice plant Tissue culture on a Budget, 2020, independently Published.
3. Agarwal, Swati, Kumari, Sonu et al., 2021. Bioentrepreneurship and Transferring Technology into Product Development. IGI Global.

<b>EXTENSION ACTIVITY</b>				
Title of the paper	Extension activity		Subject code: <b>23UPBIT1X01</b>	
Category of the course	Year	Semester	Credits	Hours
Extension activity	II	IV	1	--

