DEPT OF BIOTECHNOLOGY

M.Sc SYLLABUS

(With effect from the academic year 2022-2023 onwards)

J.J.COLLEGE OF ARTS & SCIENCE

(AUTONOMOUS)

(Reaccredited by NAAC With 4th cycle)

PUDUKKOTTAI – 622 422

J.J COLLEGE OF ARTS AND SCIENCE (AUTONOMOUS), PUDUKKOTTAI
DEPARTMENT OF BIOTECHNOLOGY
M.Sc., BIOTECHNOLOGY

Course Structure under Choice Based Credit System

(Applicable for the Candidates Admitted from Academic Year 2022-2023 Onwards)

Sem	Course Code	Course Title	Hrs/ Week	Credit	Exam Hrs	Marks		Total
						Int	Ext	
I	P1R2BTCC1	Cell and Molecular Biology	6	5	3	25	75	100
	P1R2BTCC2	Biochemistry	6	5	3	25	75	100
	P1R2BTCC3	Microbiology	6	5	3	25	75	100
	P1R2BTCC4P	Practical–I (Covering CC1,CC2 & CC3)	6	5	3	40	60	100
	P1R2BTDSE1:1 P1R2BTDSE:1:2	**Discipline Specific Elective-1**	6	3	3	25	75	100
Total			**30**	**23**	**-**	**-**	**-**	**500**
II	P2R2BTCC5	Genetics and Genetic Engineering	5	5	3	25	75	100
	P2R2BTCC6	Immunology and Immunotechnology	5	5	3	25	75	100
	P2R2BTCC7	Bioprocess Technology	5	5	3	25	75	100
	P2R2BTCC8	Bioinformatics and Biostatistics	5	5	3	25	75	100
	P2R2BTCC9P	Practical -II (Covering CC5,CC6, CC7& 8)	5	5	3	40	60	100
	P2R2BTDSE2:1 P2R2BTDSE2:2	**Discipline Specific Elective-2**	5	3	3	25	75	100
Total			**30**	**28**	**-**	**-**	**-**	**600**
III	P3R2BTCC10	Plant and Animal Biotechnology	5	5	3	25	75	100
	P3R2BTCC11	Environmental Biotechnology	5	5	3	25	75	100
	P3R2BTCC12	Medical and Pharmaceutical Biotechnology	5	5	3	25	75	100
	P3R2BTCC13	Research Methodology, IPR and Bioethics	5	5	3	25	75	100
	P3R2BTCC14P	Practical -III (Covering CC10, CC11 & CC12)	5	5	3	40	60	100
	P3R2BTSEC1:1 P3R2BTSEC1:2	**Skill Enhancement Course**	5	3	3	25	75	100
Total			**30**	**28**	**-**	**-**	**-**	**600**
IV	P4R2BTGEC1	**Generic Elective Course**	6	3	3	25	75	100
	P4R2BTCC15PW	Project Work	24	8	-			100
V	#	**Extra Credit Online Course**	-	**(4)**				
Total			**30**	**11(4)**	**-**	**-**	**-**	**200**
Grand Total			**-**	**90**	**-**	**-**	**-**	**1900**

Discipline Specific Elective Courses

Discipline Specific Elective-1

1. Biotechniques
2. Cell Signaling

Discipline Specific Elective-2

1. Regenerative Medicine
2. Green Biotechnology

Skill Enhancement Course

1. Diagnostic Biotechnology
2. Nanobiotechnology

Generic Elective Course

1. Entrepreneurship and Career Development in Biosciences

SEMESTER-I	
Title of The Course : CELL AND MOLECULAR BIOLOGY	**Category of The Course :** Core Course
Course Code : P1R2BTCC1	**Nature of The Skill :** Skill development
Marks : CIA : 25 + Ext: 75 = 100	**Hrs / Week :** 06
Credits : 5	**Total Inst.Hrs :** 72

COURSE OBJECTIVES

- This paper has been structured to give the student an in depth knowledge of the what is DNA and chromosome
- The major objective of the paper is to envisage thorough knowledge in genetics about the replication, recombination and protein synthesis
- This paper enhances the clear cut idea of basic cell biology
- It provides the proper understanding for Gene structure and its concepts.
- After successful completion of the paper the students will get an overall view about cell structure and genetic makeup of organisms and can take up a career in research.

UNIT I: **Hours: 15**

Origin of Cell - Classification of Cell types, Cell size and shape, Cell theory - Organization of plant and animal cells, Overview of the Prokaryotic and Eukaryotic cells. Structure of Plasma Membrane - Lipid Bilayer, Membrane Protein Diffusion, Osmosis, Ion Channels, Active Transport. Structural organization and function of intracellular organelles - Cell wall, Nucleus, Mitochondria, Golgi bodies, Lysosomes, Endoplasmic Reticulam, Peroxisomes, Plastids, Vacuoles, Chloroplast, Cytoskeleton.

UNIT II: **Hours: 15**

Nucleotides-DNA and RNA as a genetic material. Types, Forms,structure and functions of DNA and RNA. Details of *E.coli* chromosome, Brief account of plasmid – structure, properties types and its significance. Transposable elements in bacteria – Transposons. Genetic code,GeneStructure,Conceptofgene-expression, transcription, translation,post-

translationalandtranscriptionalmodificationGene regulation - Lac operon, trpoperon. **Gene transfer mechanism** in bacteria-conjugation,transformation,transduction- generalized and specialised .

UNIT III: **Hours: 12**

Chromatin structure: Histones, DNA, nucleosome,RepetitiveDNA,Giant chromosomes: Polytene and Lampbrush chromosomes, RNA splicing and transcription,Ribozyme,Translation Linkage and Crossing over, Population genetics, Life cycle of *Neurosporacrassa* ,Types-breakage,Rejoining and models of recombination-The Holliday model.

UNIT IV: **Hours: 15**

Replication of DNA – Enzymes involved,Models-,rollingcircle model, Theta Model. Replication of RNA – reverse transcriptase.**Mutation**-mutants,Types and significance of mutation- Frame shift,Silent,Point,Sense and Nonsense mututation,**DNA repair mechanism**-Photoreactivation, Excision repair, Proof reading activity of DNA polymerases. Transposable elements in eukaryotes.

UNIT V: **Hours: 15**

Introduction to Human Genetics-Human Chromosomes: Structure and organization of DNA,Chromosome abnormalities– Euploidy, Polyploidy. Genetic disorders- autosomal dominant and autosomal recessive disorders, Sex linked inheritance - x-linked and Y linked disorders, cancer and diabetes,Inborn errors of metabolism,Eugenics,Euthenics and Genetic counseling

TEXT BOOKS

1. Essential of molecular biology, Freifelder D. 2008, 4th edition, Jones and Bartlett publishing (Unit I-IV)
2. Cell Biology and Genetics: 1 by Cecie Starr &Ralph Taggart ,11th Revised edition (2005), Publisher: Brooks/Cole

REFERENCES

1. Molecular cell Biology, by Darnell, Lodish, Baltimore, Scientific American Books, Inc., 1994.
2. Recombinant DNA technology- Watson J.D, M Gil man et al., scientific American books-WH free man publishers
3. Cell Biology : Organelle Structure And FunctionSadava D. EReleased: 2009Publisher**:** Cbs

4. Human genetics, A.Gardner, R.T.Howell and T.Davies, Published by VinodVasishtha for Viva Books private limited, 2008.
5. Molecular spectros. Istrev.ed (english) 1st edition (s) j. D. Graybea 2014,Mcgraw hill

COURSE OUTCOMES

CELL AND MOLECULAR BIOLOGY		**Course Code : P1R2BTCC1**
S.No	**Course Outcome**	**Knowledge Level**
Upon Completion of course the students will be able to		
CO -1	understand the complete nature of cell and its organelles in detail.	**K1**
CO -2	get depth information about the process of Genetics.	**K2**
CO -3	apply their Knowledge of Genetics for the further studies or Research.	**K5**
CO -4	understand in detailed mechanisms of DNA Replication	**K3**
CO -5	understand the overall concepts of chromosomal abnormalities.	**K4**

Relationship Matrix for CO, PO, PSO

Course Outcome (CO)	**Programme Outcome (PO)**					**Programme Specific Outcome (PSO)**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PSO-1**	**PSO-2**	**PSO-3**	**PSO-4**	**PSO-5**	**Mean**
CO-1	2	2	2	1	2	3	3	2	2	3	2.2
CO-2	3	2	2	1	2	2	2	2	2	2	2.15
CO-3	2	3	2	2	2	2	3	2	3	2	2.3
CO-4	2	2	2	3	2	2	2	2	3	2	2.2
CO-5	2	2	2	2	3	2	2	3	3	2	2.3
										Mean Overall Score	**2.24**
										Result	**High**

SEMESTER- I	
Title of The Course : BIOCHEMISTRY	**Category of The Course :** Core Course
Course Code : P1R2BTCC2	**Nature of The Skill :** Knowledge Based
Marks : CIA : 25 + Ext: 75 = 100	**Hrs / Week :** 06
Credits : 6	**Total Inst.Hrs :** 72

COURSE OBJECTIVES

- To gain a basic knowledge about the chemical bonding in biological system.
- To have a detailed knowledge about the function and properties of biomolecules
- To learn about the basic metabolic reactions of living organisms
- To have a basic knowledge about the enzymes and biological energy transducers
- Describe the various metabolic pathways involved in cells for its normal functioning.

UNIT I - Chemical bonding in biological system **Hours: 15**

Percentage solution, molarity, normality, molality, properties of water- hydrogen bonding, hydrophobic interactions, acids bases and their concepts, buffers, Henderson-Hasselbatch Equation & biological buffers, and electrolytes & their functions – acidity, alkalainity and pH determination - Basic Thermodynamics, laws of thermodynamics - Enthalpy and Entropy relations.

UNIT II – Carbohydrates & its Metabolism **Hours: 15**

Carbohydrates- classification, Occurrence, isolation, purification, properties and biological reactions of polysaccharides; Glycoproteins and proteoglycans: Structural features of homoglycans, heteroglycans and complex carbohydrates.

Metabolism: Glycolysis & TCA cycle and its Energetics , Glycogenesis; Glycogenolysis; Gluconeogenesis; interconversion of hexoses and pentoses; Coordinated control of metabolism; Oxidative phosphorylation & Electron Transport Chain. Metabolic disorders associated with carbohydrate metabolism.

UNIT III - Metabolism of Amino acids & Proteins **Hours: 15**

Amino acids: Classification & physico-chemical properties of amino acids. transamination and oxidation domination reactions of amino acids. Amino acids catabolisms (phenylketonuria, albinism),

Proteins: Introduction, Classification, Polypeptides and covalent bond; Protein Stucture - Primary, secondary, tertiary and quaternary , Ramchandranplot; Denaturation and renaturation of

proteins; Protein metabolism – Urea cycle and its significance degradation and pathway controlling protein degradation. Metabolic disorders associated with protein metabolism.

UNIT IV – Metabolism of Lipids and Nucleic acids **Hours: 14**

Lipids-Classification, structure and functions: Triglycerides; Phospholipids; Steroids and Terpenes; Lipoproteins: Structure and functions of lipoproteins; Role of lipids in biomembranes; Metabolism: Biosynthesis of Fatty acids; Triglycerides; Phospholipids; Sterols. β-oxidation of fatty acids

Nucleic Acids: bases, nucleosides & nucleotides, RNA & DNA : Structure, Types and their biological significance. Forces stabilizing nucleic acid structures. Fractionation, sequencing and chemical synthesis of oligonucleotides. Metabolism: Synthesis of Purines and Pyrimidines, (de novo synthesis and savage pathway), Disorders of Nucleic acid metabolism.

UNIT V – Enzymes **Hours: 13**

Classification and nomenclature of enzymes - physico chemical nature of enzymes – enzyme kinetics – mechanism of enzyme action – factors affecting enzyme activity, industrially important enzymes.

TEXT BOOKS

1. Biochemistry, Sathyanarayanan.U and Chakrapani.C, (2013), Books and allied (P) Ltd
2. Fundamentals of Biochemistry, Deb,A.C., (7^{th} Edition). New central agency.
3. Fundamentals of Biochemistry, Jain, J.L., (2005), (6^{th} Edition), S.Chand Publications
4. Enzymes, Ashokan.P, 2006, Chinna Publications
5. Molecular Biology, Freifelder. D, 1996, II Edition, Narosa Publishing House, New Delhi.

REFERENCE BOOKS

1. Biochemistry, Zubay,G.L., 1998, Wm.C. Brown Publishers.
2. DNA structure and function, Sinden,S.R., 1994, First Edition**,** Academic Press.
3. Introduction to Protein Structure, Carl Branden and John Tooze, 1999, Second Edition, Garland Publishing.
4. Biochemistry, Garrett.R and Grisham.C, 2010, 4^{th} Edition, Saunders College Publishing.
5. Biochemistry, Hubert, styer, 1995, Freeman and Company, New York.
6. Principles of Biochemistry, Lehninger, Nelson, David.L and M.M.Cox, 2013**.** 6^{th} Edition, W.H.Freeman & Co.
7. Biochemistry, Berg, J.M *et al.*, 2012, 7^{th} Edition, W. H. Freeman & Co.

8. Fundamentals of Biochemistry: Life at the Molecular level, Voet, D. *et al.*, 2012, 4th Edition, John Wiley and Sons.
9. Essentials of medical physiology, Sembulingam.K and Prema Sembulingam, 2003, 2nd Edition, Jaypee Brothers Medical Publishers (P) Ltd.

COURSE OUTCOMES

BIOCHEMISTRY	**Course Code : P1R2BTCC2**	
S.No	**Course Outcome**	**Knowledge Level**
Upon Completion of course the students will be able to		
CO -1	Students will be imparted complete knowledge about structure and function of different biomolecules (proteins, lipids, nucleic acids, and carbohydrates) found in living cells.	**K1**
CO -2	Also the course will provide the knowledge how biomolecules are synthesized and metabolized inside living cells.	**K2**
CO -3	Acquire knowledge on the building blocks of the macromolecules, their chemical properties and their modification and their importance in normal functioning of living organisms.	**K3**
CO -4	Understand the metabolic pathways and identify how the genetic abnormalities disturb the normal homeostasis and link with pathological conditions	**K4**
CO -5	Understand the applications of biochemistry in medicine, agriculture, and pharmaceuticals	**K5**

Relationship Matrix for CO, PO, PSO

Course Outcome (CO)	**Programme Outcome (PO)**					**Programme Specific Outcome (PSO)**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PSO-1**	**PSO-2**	**PSO-3**	**PSO-4**	**PSO-5**	**Mean**
CO-1	3	2	3	2	2	3	3	2	2	3	2.5
CO-2	2	2	2	3	2	3	3	3	3	3	2.6
CO-3	3	3	2	2	2	2	3	2	3	2	2.4
CO-4	2	3	3	3	2	2	3	3	3	3	2.7
CO-5	3	2	2	2	3	2	2	3	3	2	2.4
										Mean Overall Score	**2.52**
										Result	**High**

SEMESTER-I	
Title of The Course : Microbiology	**Category of The Course :** Core Course
Course Code: P1R2BTCC3	**Nature of The Skill:** Skill Development
Marks : CIA : 25 + Ext: 75 = 100	**Hrs / Week : 06**
Credits : 5	**Total Inst.Hrs : 72**

COURSE OBJECTIVES

- To introduce the students to the field of microbiology with special emphasis on microbial diversity, morphology, physiology and nutrition; methods for control of microbes and host-microbe interactions.
- To know about the Microorganisms, its structure and classification.
- To learn about the isolation and general characteristics of Microorganisms.
- To study about the pathogens, its diagnostic methods, prevention and treatment for the diseases.
- Motivate the students to become a successful Entrepreneur.

UNIT I: Basic Microbiology **Hours: 15**

Introduction to Microbiology: Scope of microbiology and emerging avenues, Development of microbiology, Microbial taxonomy and detailed classification of the microbial world as per Bergey's manual of classification (Bacteria, Archaea, Eukarya). Microscopes: Bright field microscope; Dark field microscope; Phase contrast microscope; Fluorescent microscope; Electron microscope, Atomic Force Microscopy (AFM), Scanning Probe Microscopy techniques (SPM)

UNIT II: Ultra structure of Prokaryotic and Eukaryotic **Hours: 15**

Ultra structure of Prokaryotic and Eukaryotic cell- The Prokaryotic Cell: Size, shape and arrangement of bacterial cells; structure of cell wall, and structures external (glycocalyx, flagella, pili, etc.,) and internal (plasma membrane, cytoplasm, inclusion bodies, etc.,) to the cell wall. The Eukaryotic Cell: Actinomycetes, Algae, Fungi and Protozoa.

UNIT III: Microbial Nutrition, Growth and reproduction of microorganisms Hours: 14

Cultivation of microorganisms; culture media and types of culture media. Nutritional requirements of microorganisms - nutritional classification of bacteria. Growth curve, Mathematical expression of growth; Measurement of growth and growth yields, Counting of bacteria, Synchronous growth, and continuous culture, growth as affected by environmental factors.Reproduction - sexual and asexual.

UNIT IV: Sterilization and Preservation of Microorganisms: Hours: 14

Sterilization - Physical methods, chemical methods and Radiation methods, Antimicrobial agents, Antibiotics and their mode of action, Biosafety and levels of biosafety, Types of microbiological safety cabinets, GLP and GMP, Preservation of Microorganisms- lyophilization and Cryopreservation.

UNIT V: Medical Microbiology: Hours: 14

Diseases caused bacteria (typhoid, tuberculosis, leprosy, anthracis), virus (TMV, CMV, flu, chicken guinea, covid 19 and its subunits), fungi (Systemic mycosis, Mucor mycosis), protozoans (malaria, African sleeping sickness, amoebic dysentery) and zoonotic infections .Vaccines, Anti-microbial agents, Antibiotics and disinfectants, National Immunization Programme

TEXT BOOKS

1. Microbiology-M.J. Pelczar, Jr., E.C.S. Chang and N.R. Krieg, 1986, McGraw Hill Company, New York.
2. Microbiology L.M. Prescott, J.P., Hareley, D.A., Klein, W.M.C.,1993, Brown publishers, Dutique Jawa Melbourne.
3. A text book of Microbiology – R.C.Dubey,Dr.K.Maheswari , 2012, M.Chand Publishers 1st Edition.
4. Marine Microbial Diversity, Karl,D & Buckley,M, 2005, American academy of microbiology, Washington.

REFERENCES

1. Microbiology-Concepts and applications, M.J. Pelczar, Jr., E.C.S. Chang and N.R. Krieg, 1993, McGraw Hill Company, New York.
2. General Microbiology Vol. II – Dr.CB Powar and Dr.H.F.Daginawala, 2010,Himalaya Publishing House.

3. Biological Oceanography, Miller,C.,Wheeler,P.A, 2012, Wiley-Blackwell Scientific Publications.
4. Text book of Microbiology – D.R.Arora and B.Arora, 2008, CBS Publications; 3rd Edition

NET REFERENCES

1. www.microbeworld.org,
2. www.microbiology.org,
3. www.sheffcol.ac.uk/link/science/biology/microbiology

COURSE OUTCOMES

MICROBIOLOGY		**Course Code : P1R2BTCC3**
S.No	**Course Outcome**	**Knowledge Level**
Upon Completion of course the students will be able to		
CO -1	Basic knowledge on different structure and characteristics of microbe.	**K1**
CO -2	Understand the applied aspects of microbiology	**K5**
CO -3	Understand the role of beneficial microorganisms in the environment and the application to benefit mankind.	**K3**
CO -4	List and describe the mechanisms of action of major chemotherapeutic agents that control microorganisms.	**K5**
CO -5	Explain about factors responsible for the virulence of different pathogenic microorganisms.	**K2**

Relationship Matrix for CO, PO, PSO

Course Outcome (CO)	**Programme Outcome (PO)**					**Programme Specific Outcome (PSO)**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PSO-1**	**PSO-2**	**PSO-3**	**PSO-4**	**PSO-5**	**Mean**
CO-1	3	2	2	2	2	3	3	2	2	3	2.4
CO-2	2	2	3	1	2	2	2	2	2	2	2
CO-3	2	3	3	2	3	2	3	3	3	3	2.7
CO-4	3	2	3	3	2	2	2	2	2	2	2.3
CO-5	2	2	2	2	3	2	2	3	3	2	2.3
										Mean Overall Score	**2.34**
										Result	**High**

SEMESTER-I	
Title of The Course : PRACTICAL-I (COVERING CC1, CC2 AND CC3)	**Category of The Course :** Core Course
Course Code : P1R2BTCC4P	**Nature of The Skill:** Skill Development
Marks : CIA : 40 + Ext: 60 = 100	**Hrs / Week :**06
Credits : 5	**Total Inst.Hrs :** 72

COURSE OBJECTIVES

- To get a basic idea about Microbiology.
- To learn about the classification of Microorganisms.
- To know about the general characteristics and pathogenicity of Microorganisms.
- To enhance the students' knowledge on the historical aspects and development of microbiology
- To acquire an overall knowledge on the morphology and functions of the structures with the prokaryotes and eukaryotes.

MICROBIOLOGY

1. Do's and Don'ts.
2. Preparation of solutions in different concentration.
3. Preparation of solid and liquid culture media,
4. Pure culture techniques – Pour plate, Spread plate and Streak plate method.
5. Identification of microorganisms: Macroscopic, Microscopic: staining techniques – simple, gram staining, capsule staining, spores staining and acid for staining . Motility- Hanging Drop Technique and stabbing. Biochemical tests –IMViC tests, Carbohydrate fermentation, Amylase production, Catalase, Oxidase, Urease and TSI .
6. Microscopic identification of fungi – Lactophenol cotton blue wet mount
7. Identification of actinomycetes – Microscopic and biochemical tests
8. Measurement of microorganisms – Micrometry
9. Determination of microbial growth: Turbidity method and counting chamber method.
10. Isolation, cultivation and identification of algae from different water sources.

BIOCHEMISTRY

1. Preparation of standard solutions.
2. Method for measurement of pH.

3. Preparation of buffers solutions.
4. Reactions of Carbohydrates(Ribose, Glucose, Fructose, Sucrose, Starch)
5. Qualitative tests for Lipids.
6. Qualitative tests for Aminoacids
7. Qualitative tests for Proteins.
8. Qualitative tests for Nucleic acids
9. Analysis of Normal urine.
10. Analysis of abnormal urine.
11. Estimation of glucose
12. Estimation of protein
13. Estimation of cholesterol
14. Estimation of creatinine

GENETICS AND MOLECULAR BIOLOGY

1. Isolation of Genomic DNA
2. Estimation of DNA
3. Isolation of Plasmid DNA
4. Isolation of Auxotrophic mutants
5. Mutagenesis in Bacteria
6. Physical method-UV rays
7. Chemical method N-methyl-W-nitro-N-nitrosogunidine

REFERENCES:

1. Sundaraj T, Mrs. Aswathy Sundararaj. (2002) Microbiology Laboratory Manual, First edition, Chennai.
2. Laboratory Manual in General Microbiology (2002) by N. Kannan. Panima Publishers.
3. Dubey, R.C. and Maheshwari, O.K. (2005) Practical Microbiology. S, Chand and Co.Ltd., First edition. New Delhi.
4. Cappuccino, J and Sherman, N. (2002) Microbiology. A Laboratory Manual . 6th Edition. Pearson Education Publication, New Delhi.

NET REFERENCES:

1. www.microbeworld.org
2. www.microbiologyonline .org.uk/links.htm
3. www.sheffcol.ac.uk/link/science/biology/microbiology
4. www.cat.cc.md.us/course/bio141/lab manual/index.html

COURSE OUTCOMES

PRACTICAL-I (COVERING CC1, CC2, & CC3)		**Course Code : P1R2BTCC4P**
S.No	**Course Outcome**	**Knowledge Level**
Upon Completion of course the students will be able to		
CO -1	Be impressed on the milestones of Microbiology and present status	**K1**
CO -2	Identify key components and their functions in both prokaryotes and eukaryotes.	**K5**
CO -3	Know various Culture media and their applications and also understand various physical and chemical means of sterilization.	**K3**
CO -4	Understand the microbial transport systems and the modes and mechanisms of energy conservation in microbial metabolism.	**K5**
CO -5	Know the various Physical and Chemical growth requirements of bacteria and get equipped with various methods of bacterial growth measurement.	**K2**

Relationship Matrix for CO, PO, PSO

Course Outcome (CO)	**Programme Outcome (PO)**					**Programme Specific Outcome (PSO)**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PSO-1**	**PSO-2**	**PSO-3**	**PSO-4**	**PSO-5**	**Mean**
CO-1	2	2	2	1	2	3	3	2	2	3	2.2
CO-2	3	2	2	1	2	2	2	2	2	2	2.15
CO-3	2	3	2	2	2	2	3	2	3	2	2.3
CO-4	2	2	2	3	2	2	2	2	3	2	2.2
CO-5	2	2	2	2	3	2	2	3	3	2	2.3
										Mean Overall Score	**2.24**
										Result	**High**

SEMESTER-I	
Title of The Course : BIOTECHNIQUES	**Category of The Course :** Discipline Specific Elective
Course Code : P1R2BTDSE1:1	**Nature of The Course :** Employability
Marks : CIA : 25 + Ext: 75 = 100	**Hrs / Week :** 06
Credits : 3	**Total Inst. Hrs :** 72

COURSE OBJECTIVES

- Thorough understanding of the analytical techniques and equipment used in Biological science**.**
- To have a fundamental knowledge regarding the Microscopy, Spectroscopy, Centrifugation.
- To acquire knowledge on the Chromatographic method for the separation of biological products
- To acquaint the students with various techniques used in biological sciences and the emerging areas of biotechnology along with underlying principles.
- To make students learn about modern instruments for various analytical works

UNIT I: Basic Instruments **Hours: 14**

pH meter, isoelectric focusing. Principles and application of light microscopy, phase Contrast, Bright and Dark field Microscopy fluorescence Microscopy, Electron Microscopy- TEM, SEM, Confocal microscopy and Atomic absorption microscopy.

UNIT II: Separation Techniques **Hours: 15**

Basic principle of centrifugation**,** and its types - Ultra Centrifugation (Preparative and analytical), Density gradient Centrifugation, Rate zonal centrifugation, Differential centrifugation. Standard Sedimentation coefficient. **Chromatography:** Chromatography - Principle, instrumentation and application of Paper Chromatography, Adsorption chromatography, Ion exchange Chromatography, Thin layer Chromatography, Affinity chromatography, HPLC and GC.

UNIT III: Diffraction Methods **Hours: 15**

Principles, Components and applications of X-ray crystallography. Braggs equation, Reciprocal lattice concept, Miller index and Unit cell, Determination of crystal structure, colorimeter, Spectroscopy – Raman effect, UV-Visible, Mass spectroscopy, Atomic Absorption spectroscopy,

NMR –Experimental techniques and instrumentation, ESR. LASER and MASER - Principle and applications**.**

UNIT IV: Tracer Techniques **Hours: 14**

Radioactive and stable isotopes: Pattern and rate of radioactive decay isotope-Half life, GM Counter, solid and Liquid scintillation counter, Radiation dosimetry, Radio tracer technique, Autoradiography. Application of isotopes in Biology.

UNIT V: Electrophoretic Techniques **Hours: 14**

Electrophoresis- Agarose Gel Electrophoresis, SDS-PAGE, Native Gel, 2D gel and gradient Gel Electrophoresis, Pulsed field Gel Electrophoresis (PFGE).

TEXT BOOKS

1. Biophysical chemistry – principles and techniques, Upadhyay , Upadhyay and Nath, 3 rd edition , 2002, Himalaya publishing home.
2. Laboratory manual in biochemistry, J.Jayaram 1981, Wiley publisher.
3. Bioinstrumentation, L. Veerakumari, 1st edition 2011, MJP publishers**.**

REFERENCE BOOKS

1. Analytical biochemistry and separation techniques-A laboratory manual, P.Palanivelu 2nd edition 2001 tulsi books centre**.**
2. Principles and techniques of practical biochemistry, Keith Wilson and John walker, 5th edition 2000, Cambridge University press.
3. Analytical biochemistry, D. Holme and H.Peck, 3rd edition 1998, longman.
4. Physical biochemistry- application to biochemistry and molecular biology, Freifelder, 2nd edition, 1982, W. H.Freeman and company, San Fransisco.

NET REFERENCES:

1. www.explainthe stuff.com
2. www.chemguide.co.uk.

COURSE OUTCOME

BIOTECHNIQUES		**Course Code: P1R2BTDSE1:1**
S. No.	**Course Outcome**	**Knowledge Level**
Upon completion of the course, the students will be able to		
CO - 1	understand general laboratory procedures and maintenance of research equipments, microscopy, pH meter and preparation of different buffers	**K1**
CO - 2	describe the pH measurement in soil and water samples	**K3**
CO - 3	understand how to isolate cellular constituents	**K2**
CO - 4	realize the need of centrifuges and their uses in research	**K4**
CO - 5	apply the concepts of bioanalytical techniques in biotechnology research	**K4**

Relationship Matrix for CO, PO, PSO

Course Outcome (CO)	**Programme Outcome (PO)**					**Programme Specific Outcome (PSO)**					
	PO1	**PO2**	**PO-3**	**PO-4**	**PO-5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**Mean**
CO-1	3	2	2	2	2	3	3	2	2	3	2.4
CO-2	2	2	3	1	2	2	2	2	2	2	2
CO-3	2	3	3	2	3	2	3	3	3	3	2.7
CO-4	3	2	3	3	2	2	2	2	2	2	2.3
CO-5	2	2	2	2	3	2	2	3	3	2	2.3
										Mean Overall Score	**2.34**
										Result	**High**

SEMESTER – I	
Title of The Course : Cell Signaling	**Category of The Course :** Disicipline Specific Elective
Course Code : P1R2BTDSE:1:2	**Nature of The Skill :** Skill Development
Marks : CIA : 25 + **Ext**: 75 = 100	**Hrs / Week : 06**
Credits : **3**	**Total Inst. Hrs :72**

COURSE OBJECTIVES

- To impart basic knowledge about cells & their matrix Systems
- To understand the importance of proteins in signaling
- To be effective in hormones and growth factors in signaling system of plants & animals
- To acquire knowledge on cancer cell communication & their genes.
- To gain the knowledge of interaction between host and parasites.

Unit – I Extra Cellular Matrix and Cell Surface **Hours: 15**

Extra Cellular Matrix (ECM) and Cell Surface: Molecules in the ECM in plant and animals. Transport across cell membrane, Ficks Law. Types of transport - simple, passive, facilitated. Active transport, primary and secondary active transport system. Ionophores, gated channels (Voltage and Ligand). Cell communication and type of signaling molecules..

Unit – II Cell Communication Receptors **Hours: 15**

Types of receptors and their structure. GPCR, inhibitory and stimulatory and type of wn-stream effectors and signal termination. Monomeric G-proteins their role. Drugs targeting signaling molecules Concept of transducers, effectors, GTP binding proteins - Gi, Gs, Gp, Gq, ras; adenylate cyclase, guanylate cyclase, phosphodiesterases, Protein kinase (PK) (PKs associated with cell survival and death processes)

Unit – II Cell Signaling in Plants &Animals **Hours: 15**

Cell signaling: Various types cell signaling. Cell signaling molecules: Hormones and growth factors, neurotransmitters, peptide hormones, steroid hormones, eicosanoids, vitamins and gases. Cell signaling: Cell signaling in neurons - Cell signaling in immune system. Cross talk between signaling pathways. signal transduction pathways, regulation of signaling pathways. Plant signaling system an

over view, Stress signaling in plants (biotic), Stress signaling in plants (abiotic). Plant hormones and their mechanism of action.

Unit – IV Cancer Cell Communication **Hours: 12**

Cancer Cell Communication : Discovery of oncogenes, proto-oncogenes. Modes of action of oncogenes – G proteins – Ras. Growth factors – Erb, Sis. Transcription factors – Fos, Jun, AP1, V-erbA. Discovery of tumor suppressor genes. RB and retinoblastoma, APC and colon cancer. Modes of action of TS genes – p110, p16, p21, Phosphatase and tensin homolog (pTEN). p53 and cancer risk. Selected examples – c-Myc and leukemia. BRCA and breast cancer.

Unit – V Signal Transduction in Pathogens **Hours: 15**

Host parasite interaction Recognition and entry processes of different pathogens like bacteria, viruses into animal and plant host cells, alteration of host cell behavior by pathogens, virus-induced cell transformation, pathogen-induced diseases in animals and plants, cell-cell fusion in both normal and abnormal cells. Signaling in yeast: STAT pathway in yeast

TEXT BOOKS

1. Michel Friedman and Brett Friedman. 2004. Cell communication: Understanding how information is stored and used in cells. Ingram International Inc.
2. John T Hancock. 2005. Cell signaling. Oxford University press.

REFERENCE BOOKS

1. Geoffery M Cooper and Robert E Hausman. 2009. The Cell and Molecular Approach. (Ed: 5). ASM Press and Sinauer Associates Inc.
2. Gomperts, Basten D, Ijbrand M Kramer and Peter ER Tatham. 2009. Signal transduction. (Ed:2). Academic Press.
3. Ernst JM Helmreich. 2001. The Biochemistry of cell signaling. Oxford Universiy Press.
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- http://www.landesbioscience.com/journals/BioArchitecture/about/
- *http://expmed.bwh.harvard.edu/main/labs.html*
- *http://www.unc.edu/depts/salmlab/mafia/mafia.html*

COURSE OUTCOMES

CELL SIGNALING		**Course Code: P1R2BTDSE1:2**
S. No.	**Course Outcome**	**Knowledge Level**
Upon completion of the course, the students will be able to		
CO - 1	understand the transport system between the cells in detail.	**K2**
CO - 2	gain depth knowledge in the intracellular cascades and cellular activities.	**K3**
CO - 3	gain knowledge of signaling molecules & pathways of both plant and animals	**K2**
CO - 4	exhibit the knowledge in cancer cell communication & genetic expressions.	**K4**
CO - 5	evaluate their knowledge on variations in signal transductions of microbes	**K4**

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Relationship Matrix for CO, PO, PSO

Course Outcome (CO)	**Programme Outcome (PO)**					**Programme Specific Outcome (PSO)**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PSO-1**	**PSO-2**	**PSO-3**	**PSO-4**	**PSO-5**	**Mean**
CO-1	3	2	3	2	2	3	3	2	2	3	2.5
CO-2	2	2	2	1	2	2	3	3	2	3	2.2
CO-3	2	3	2	2	2	2	2	2	3	2	2.2
CO-4	2	2	3	3	2	2	2	2	2	2	2.2
CO-5	2	2	2	2	3	2	2	3	3	2	2.3
										Mean Overall Score	**2.28**
										Result	**High**

SEMESTER-II	
Title of The Course : Genetics and Genetic Engineering	**Category of The Course :** Core Course
Course Code : P1R2BTCC5	**Nature of The Skill :** Knowledge Based
Marks : CIA : 25 + Ext: 75 = 100	**Hrs / Week :** 05
Credits : 5	**Total Inst. Hrs :** 60

COURSE OBJECTIVES

- To know the fundamental aspects of human heredity.
- To make them understand the factors which influence the inheritance.
- To make them familiar with the tools available to test the inheritance of congenital diseases and gene therapy.
- To play a key role in the diagnosis, prognosis and selection and monitoring of treatment.
- To know in outline the development steps in sex determination.

UNIT I: **Hours:12**

Introduction to Genetics, Mendelian Genetics. Definitions-Alleles, Phenotypes, Genotypes, Dominance, Incomplete Dominance, co-dominance, Recessiveness, Homozygous, Heterozygous, Hemizygous. Multiple Alleles, ABO blood groups, Epistasis, Pleiotropy. Mendelian inheritance in humans–Segregation and Independent Assortment. Types of inheritance, Autosomal Recessive, Autosomal Dominant, Sex-linked Dominant and Sex-linked Recessive. Pedigree Analysis of the different types of inheritance.

UNIT II: **Hours:12**

Human chromosome set. Analysing chromosomes and Karyotype. Making a karyotype and obtaining cells. Amniocentesis, chorionic villi sampling-Variation in chromosome number of sets. Polyploidy, Aneuploidy, Autosomal Monosomy, Autosomal trisomy. Risks for autosomal trisomy. Aneuploidy of

the sex chromosomes. Turner syndrome, Kleinfelder Syndrome, XYY. Structural Alterations– Deletions and translocations, Fragility and Uniparental Disomy.

UNIT III: **Hours:12**

Milestones in the development of genetic engineering. Molecular tools in genetic engineering - vectors, enzymes – restriction endonuclease. DNA ligase, Acid phosphatase and other DNA modifying enzymes. Restriction enzymes - restriction sites- cloning of blunt end DNA, adapters. cDNA library. Gene cloning and gene expression. DNA analysis: labeling of DNA and RNA probes. Fluorescence in situ hybridization, DNA fingerprinting and chromosome walking.

UNIT – IV: **Hours:12**

Southern, Northern and Western blotting, Gel retardation technique, DNA foot printing, Primer extension, S1 mapping, Reporter assays. DNA sequencing and sequence assembly. Maxam-Gilbert‟s and Sanger‟s methods, techniques of in vitro mutagenesis, Site-directed mutagenesis, Shot gun sequencing, chemical synthesis of oligonucleotides; sequencing strategies for large genomes. PCR-Principle and applications, various types of PCR..

UNIT – V: **Hours:12**

Physical and molecular mapping. Industrial production of animal and plant proteins in microbes - Industrial application of genetic engineering. RFLP, RAPD,RLGS, AFLP STS, EST, SSCP, VNTR, Multi locus probes, Microsatellites and minisatellites, STMS, DAF, AP-PCR, Gene therapy. Protein engineering Metabolic Engineering,

REFERENCES

1. Tamarin, R.H., “Principles of Genetics”, Tata Mc Graw Hill, New Delhi, 2002
2. DeRoberti’s, E.D. P. and DeRoberti’s, E.M. “Cell and Molecular Biology”, 8th Edition, Lippincott Williams &Wilkins, New York, USA, 2001.
3. Gardner, E.J, Simmons, M.J, and Snustad, D.P., “Principles of Genetics”,8th Edition, John Wiley & Sons, Singapore,2003.
4. Strickberger, M.W. “Genetics”, 3rdEdition, Prentice Hall of India, NewDelhi, 2008.
5. Klug, W.S. and Cummings, M.R., “Concepts of Genetics”, Pearson Education, NewDelhi, 2003.

COURSE OUTCOMES

GENETICS AND GENETIC ENGINEERING		**Course Code : P1R2BTCC5**
S.No	**Course Outcome**	**Knowledge Level**
Upon Completion of course the students will be able to		
CO -1	Understand the genetic methodology and quantification of heritable traits in families and populations and have an insight into cellular and molecular mechanisms	**K1**
CO -2	Understand how genetic concepts affect broad societal issues including health and disease, food and natural resources, environmental sustainability, etc.	**K2**
CO -3	Understand the role of genetic mechanisms in evolution.	**K5**
CO -4	Recognize the experimental rationale of genetic studies	**K3**
CO -5	Evaluate conclusions that are based on genetic data.	**K4**

Relationship Matrix for CO, PO, PSO

Course Outcome (CO)	**Programme Outcome (PO)**					**Programme Specific Outcome (PSO)**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PSO-1**	**PSO-2**	**PSO-3**	**PSO-4**	**PSO-5**	**Mean**
CO-1	3	2	2	2	2	3	3	2	2	3	2.4
CO-2	2	2	3	1	2	2	2	2	2	2	2
CO-3	2	3	3	2	3	2	3	3	3	3	2.7
CO-4	3	2	3	3	2	2	2	2	2	2	2.3
CO-5	2	2	2	2	3	2	2	3	3	2	2.3
										Mean Overall Score	**2.34**
										Result	**High**

SEMESTER – II	
Title of The Course : Immunology and Immunotechnology	**Category of The Course** : Core Course
Course Code : P2R2BTCC6	**Nature of The Course** : Knowledge Based
Marks : CIA : 25 + Ext: 75 = 100	**Hrs / Week :** 05
Credits : 5	**Total Inst.Hrs :** 60

COURSE OBJECTIVES:

- This course is designed to impart the students to understand the importance of immunology and its theoretical aspects and on the principles of immunology and immunotechnology.
- It also explains the properties of antigens, antibodies and Complements
- Students will learn about the structural features of the components of the immune system as well as their functions and responsiveness.
- The student will able to learn with the techniques of immunology the various antigen-antibody reactions involved in diseases
- The student will able to learn with the basic concepts of vaccine and interferons

UNIT I: Immune system and Immune Response **Hours: 10**

Types of immunity, Cells of immune systems, Phagocytosis, Organs of immune system- Primary and secondary lymphoid organs. Primary and secondary immune response, Clonal selection theory.

Unit II: Antigens and Antibodies **Hours: 11**

Antigens – Definition, Structure, properties and types - Haptens and adjuvants. Antibody – Structure, Types, properties and their biological functions, poly clonal sera. Theories of Antibody formation, Complement system - component, properties and functions. Complement pathways and biological significance.

UNIT III: Major Histocompatibility Complex, Allergy and Autoimmunity **Hours: 14**

Structure and functions of MHC and HLA systems. Genetic control of immune response. Tissue transplantation- Tissue typing methods for tissue and organ transplantations. Graft versus host reaction and rejection, xenotransplantation, immunosuppressive therapy. Hypersensitivity Reactions: Allergy, Hypersensitivity reactions- types (I, II, III, and IV), Autoimmunity Autoimmunity- Autoimmune diseases- Hashimoto's disease, Systemic lupus erythematosus, AIDS.

Unit IV: Immunological Techniques **Hours: 11**

Agglutination - Blood grouping, Widal test, Precipitation - Immunodiffussion-Single, Double, Radial and Rocket Immunoelectrophoresis, immune- fluorescence, immunoblotting, complement fixation test, immunoassays - ELISA, RIA, Chemiluminescence immunoassay(CLIA)

, Flow cytometry. Coomb's test , RT-PCR.

UNIT V: Types of Immunotherapy **Hours: 14**

Vaccines - conventional, viral vaccines, vaccines to other infectious agents, tumor vaccines , Peptide vaccines, subunit, DNA vaccines. Toxoids, antisera, edible vaccines, plantibodies, ISCOMs, recombinant antibodies, Immune stimulatory complexes. Common immunization programmes and role of WHO in immunization programs - BCG, Hepatitis - B and Corona Vaccines. Interferons – types and functions. Production and purification of Monoclonal antibodies.

TEXT BOOKS

1. Janeway's Immunobiology, 2022, Kenneth M. Murphy and Casey Weaver 9th edition
2. Immunology by I.M. Roitt, J.Brostoff and D.K Male (1993) Gower medical publishing, London
3. J.Kuby, 2003, Immunology 5th edition, W.H. Freeman and Company, Newyork.. 2. C.V.Rao. 2002,

REFERENCES

1. An Introduction to Immunology, Narosa Publishing House, Chennai. 3. K.M.Pavri. 1996, Challenge of AIDS, National Book Trust, India.
2. I.R.Tizard, 1995, Immunology: An Introduction, 4th edition, Saunders College Publishers, New York. 5.

Online tools [MOOC, SWAYAM, NPTEL, Websites etc.]

1. https://www.nature.com/ni/video
2. https://www.cell.com/immunity/home
3. https://www.wpunj.edu/sec/vsec/science_courses/bio/BIOimmuANIM.
   html

COURSE OUTCOMES

IMMUNOLOGY & IMMUNOTECHNOLOGY		**Course Code :** P2R2BTCC6
S.No	**Course Outcome**	**Knowledge Level**
Upon Completion of course the students will be able to		
CO -1	Get a deep foundation in the immunological processes	**K1**
CO -2	Understand the antigens and antibodies	**K2**
CO -3	Exemplify the adverse effects of immune system including Allergy, hypersensitivity and autoimmunity	**K2**
CO -4	Apply basic techniques for identifying antigen antibody interactions	**K3**
CO -5	Understand the principles and applications of vaccines and interferons	**K5**

Relationship Matrix for CO, PO, PSO

Course Outcome (CO)	**Programme Outcome (PO)**					**Programme Specific Outcome (PSO)**					
	PO-1	**PO2**	**PO-3**	**PO-4**	**PO-5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**Mean**
CO-1	3	2	3	2	2	3	3	2	2	3	2.5
CO-2	2	2	2	1	2	2	3	3	2	3	2.2
CO-3	2	3	2	2	2	2	2	2	3	2	2.2
CO-4	2	2	3	3	2	2	2	2	2	2	2.2
CO-5	2	2	2	2	3	2	2	3	3	2	2.3
										Mean Overall Score	**2.28**
										Result	**High**

SEMESTER - II	
Title of The Course : BIOPROCESS TECHNOLOGY	**Category of The Course :** Core Course
Course Code : P2R2BTCC7	**Nature of The Skill :** Employability
Marks : CIA : 25 + Ext: 75 = 100	**Hrs / Week :** 05
Credits : 5	**Total Inst. Hrs :** 60

COURSE OBJECTIVES

- To study the principles and methodologies of Industrial Biotechnology.
- To get an idea about the applications of Biotechnology in Industries.
- Motivate the students to form the Industries and R&D Labs.

UNIT I: Introduction to Bioprocess Technology **Hours: 12**

Introduction - history - isolation and screening of industrially important microorganisms, enrichment liquid culture, enrichment cultures using solid media. Preservation and storage of microbial cultures - improvement of the strains for increased yield and other desirable characteristics.

UNIT II: Sterilization and Growth Kinetics **Hours: 12**

Microbial growth kinetics – Batch culture, fed-batch culture and continuous culture, up-stream processing - media formulation for industrial fermentation. Sterilization: Batch and continuous sterilization systems - filter sterilization.

UNIT III: Bioreactors **Hours: 12**

Bioreactors - modeling and Design of bioreactors and components of bioreactor, types of bioreactor : continuous stirred tank bioreactor, air-lift bioreactor, packed bed reactor, tower fermentor,packed bed reactor, Trickle bed reactors and specialized bioreactor – fluidized bed bioreactor, photo bioreactor. Design of bioreactors – measurement and control of bioprocess parameters.

UNIT IV: Microbial Products **Hours: 12**

Industrial production of chemicals : production of industrial Enzymes Amylase, protease, pectinase, cellulose, acids citric acid, gluconic acid alcohol (Ethanol), Beverages(wine), Bakery products (Bread), antibiotics penicillin, vaccine (polio), SCP (spirulina), vitamins(vitamin B12).

UNIT V: Downstream Processing **Hours: 12**

Downstream processing – removal of microbial cells and solid media, foam separation, precipitation, filtration, centrifugation, cell disruption, liquid-liquid extraction, chromatography, membrane process, drying and crystallization.

TEXT BOOKS

1. Biotechnology: A text book of Industrial microbiology – Wulf crueger and Anne liese crueger (second editon), Panima publishing corporation, New Delhi/Bangalore (2000).
2. Industrial Microbiology – A.H.Patel,Mac Millan India Edition (2011).

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1. Principles of fermentation technology - P.F. Stanbury, A. Whitaker and S.J. Hall Elsevier publication, second edition, 2005.
2. Reviere, J, 1996, Industrial application of Microbiology, Surey University Press.
3. Demain AL., AL and Solman, NA, 1996, Manual of Industrial Microbiology, American Society of Microbiology, Washington DC.
4. Boetaert, Wim / Vandamme, Erick J. (eds.).Industrial Biotechnology 1st Edition April 2010.
5. Industrial Biotechnology – Dr.Rita Singh and S.K.Ghosh,Global vision publishing., 1st Edition (2013).
6. Industrial microbiology – L.E. Casida, New Age International (P) Ltd, New Delhi.

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1. www.microbes.info
2. www.fsis.usda.gov
3. www.livescience.asu.edu/text/classesbk.html

COURSE OUTCOMES

BIOPROCESS TECHNOLOGY		**Course Code : P2R2BTCC7**
S.No	**Course Outcome**	**Knowledge Level**
Upon completion of course, the students will be able to		
CO - 1	Discuss the history and role of microbes in industrial production of microbes.	**K1**
CO - 2	Evaluate various screening methodology,strain	**K2**
CO - 3	Outline the different types of fermentation technology and its application	**K5**
CO - 4	Design and describe various control parameters in a bioreactor	**K3**
CO - 5	Examine the procedure and techniques used in downstream process for product recovery and purification.	**K4**

Relationship Matrix for CO, PO, PSO

Course Outcome (CO)	**Programme Outcome (PO)**					**Programme Specific Outcome (PSO)**					
	PO-1	**PO2**	**PO-3**	**PO-4**	**PO-5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**Mean**
CO-1	3	2	2	2	2	3	3	2	2	3	2.4
CO-2	2	2	3	1	2	2	2	2	2	2	2
CO-3	2	3	3	2	3	2	3	3	3	3	2.7
CO-4	3	2	3	3	2	2	2	2	2	2	2.3
CO-5	2	2	2	2	3	2	2	3	3	2	2.3
										Mean Overall Score	**2.34**
										Result	**High**

SEMESTER - II	
Title of The Course: BIOINFORMATICS AND BIOSTATISTICS	**Category of The Course:** Core Course
Course Code: P2R2BTCC8	**Nature of The Skill :** Knowledge Based
Marks : CIA : 25 + Ext: 75 = 100	**Hrs / Week :** 05
Credits : 5	**Total Inst. Hrs :** 60

COURSE OBJECTIVES

- To state and comprehend the fundamental concepts of database system and its architecture, importance of biological database in the current time
- To extend comprehensive knowledge about data mining and Big data analysis and its complexity.
- To demonstrate concept about Biological problem solving, regarding to sequence alignment and Genome editing, motif finding with the help of specific algorithms
- To gain knowledge about the techniques for molecular modelling and drug designing
- To acquire knowledge regarding the tools in Bioinformatics.

UNIT I: DATABASES **Hours: 12**

Introduction to Computers - Bioinformatics**.** Biological databases - protein sequence databases – PIR, SWISS-PROT, Nucleic acid sequence database, GenBank, structural DB – SCOP, CATH specialized genome sequence database.

UNIT II: SEQUENCE ALIGNMENT **Hours: 12**

Pairwise alignment – Dot plots – scoring matrices – Blosum matrices – PAM matrix – Gap penalty – Alignment algorithms: Needle man – Wunsch global – Alignment algorithm: Smith – Waterman local alignment algorithm.

UNIT III: STRUCTURE PREDICTION **Hours: 12**

Secondary structure prediction – chou – Fasman – Jpred – Q3 – Transmembrane protein prediction- Tertiary structure prediction – Comparitive modeling – Fold recognition – Ab initio prediction – modeler – RASMOL – SWISS PDB Viewer.

UNIT IV: PHYLOGENETIC ANALYSIS **Hours: 12**

Evolutionary analysis: distances – clustering methods — rooted and un-rooted tree representation – Bootstraping strategies – Construction of phylogenetic trees, Molecular clocks Vlidation methods, Softwares for Phylogenetic analysis.

UNIT V: BIO-STATISTICS AND TESTING OF HYPOTHESIS **Hours: 12**

Introduction of Bio-Statistics and correlation Hours:12 Introduction to Bio-Statistics – Definition of Bio-statistics – Development of Bio_statistics – Application of Bio-statistics – Role of Bio-statistics. Test of significance – Test for mean and difference of means – Student t - test, Chi - Square test, F-test, ANOVA: one way and two way classification

TEXT BOOKS

1. Introduction to Bioinformatics, Sundarajan. S and R. Balaji (2205) Himalaya Publishing House, Mumbai.
2. Bioinformatics-Concepts, skills and applications,S.C.Rastogi,2nd Edition,2009,CBS Publications**.**

REFERENCE BOOKS

1. Introduction to bioinformatics, Arthur M.Lesk, 1st Edition,2002,Oxford University Press.
2. Bioinformatics – Sequence, structure and databanks, D. Higgins and W. Taylor (Eds), Oxford University Press, New Delhi (2000).
3. Introduction to computational Biology Michael S. Watermann, Chapman & Hall (1995).

COURSE OUTCOMES

BIOINFORMATICS AND BIOSTATISTICS		**Course Code : P2R2BTCC8**
S.No	**Course Outcome**	**Knowledge Level**
Upon Completion of course the students will be able to		
CO – 1	Explain the theoretical knowledge of database system and algorithms	**K1**
CO – 2	Analyze and discuss the results in light of molecular biological knowledge (sequence alignment and phylogenetic tree plot)	**K2**
CO – 3	Collect the proficient knowledge to solve biological system- a multi-disciplinary problem	**K3**
CO – 4	Develop the key skills of molecular modeling techniques currently practiced in any pharmaceutical research and development unit.	**K4**
CO – 5	Predict protein structure	**K5**

Relationship Matrix for CO, PO, PSO

Course Outcome (CO)	**Programme Outcome (PO)**					**Programme Specific Outcome (PSO)**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PSO-1**	**PSO-2**	**PSO-3**	**PSO-4**	**PSO-5**	**Mean**
CO-1	2	2	2	1	2	3	3	2	2	3	2.2
CO-2	3	2	2	1	2	2	2	2	2	2	2.15
CO-3	2	3	2	2	2	2	3	2	3	2	2.3
CO-4	2	2	2	3	2	2	2	2	3	2	2.2
CO-5	2	2	2	2	3	2	2	3	3	2	2.3
										Mean Overall Score	**2.24**
										Result	**High**

SEMESTER-II	
Title of The Course: Practical II (Covering CC5,CC6,CC7&CC8)	**Category of The Course :** Core Course
Course Code : P2R2BTCC9P	**Nature of The Skill :** Employability
Marks : CIA : 40 + Ext: 60 = 100	**Hrs / Week :** 05
Credits : 5	**Total Inst.Hrs : 60**

GENETICS AND GENE TECHNOLOGY

1. Preparation of solutions for Molecular Biology experiments.
2. Isolation of chromosomal DNA from bacterial cells.
3. Isolation of Plasmid DNA by alkaline lysis method
4. Agarose gel electrophoresis.
5. Polyacrylamide Gel Electrophoresis & GDS Analysis.
6. Blotting techniques.
7. Preparation of restriction enzyme digests of DNA samples
8. Restriction digestion of DNA
9. Making competent cells
10. Demonstration of PCR
11. Electroporation

IMMUNOLOGY AND IMMUNOTECHNOLOGY

1. Total leucocytes count
2. Total RBC & WBC count
3. Haemagglutination assay
4. Separation of serum from blood
5. Double immunodiffusion test using specific antibody and antigen.
6. Immunoelectrophoresis
7. ELISA.
8. Differential leucocytes count

BIOPROCESS TECHNOLOGY

1. Production and analysis of ethanol.
2. Production and analysis of amylase.
3. Production and analysis of lactic acid.
4. Isolation of industrially important microorganism from natural resource.

BIOINFORMATICS

1. Sequence information resource
2. Understanding and use of various web resources: EMBL, Genbank, Entrez, Unigene,Protein information resource (PIR)
3. Understanding and using: PDB, Swissprot, TREMBL
4. Using various BLAST and interpretation of results.
5. PROTPARAM, SOPMA.
6. Sequence alignment using BLAST.
7. Multiple sequence alignment using Clustal W.
8. Determination of statistical average: Arithmetic mean, Median, Mode.
9. Determination of measure of dispersion: Mean deviation, Standard deviation, Co efficient of variation.
10. Test of significance: Chi square test, t –test, Standard error.

REFERENCE BOOKS

1. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
3. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
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5. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
6. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
7. Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.

8. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.
9. Brown TA. (2006). Gene Cloning and DNA Analysis. 5th edition. Blackwell Publishing,
10. Sambrook J, Fritsch EF and Maniatis T. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press.
11. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6 th edition Saunders Publication, Philadelphia.
12. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology. 11thedition Wiley-Blackwell Scientific Publication, Oxford.
13. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.
14. Murphy K, Travers P, Walport M. (2008). Janeway's Immunobiology. 7th edition Garland Science Publishers, New York.
15. Peakman M, and Vergani D. (2009). Basic and Clinical Immunology. 2nd editionChurchill Livingstone Publishers, Edinberg.
16. Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.
17. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.
18. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell.
19. Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics. IIEdition. Benjamin Cummings.

COURSE OUTCOMES

PRACTICAL II (COVERING CC5,CC6,CC7&CC8)		**Course Code : P2R2BTCC9P**
S.No	**Course Outcome**	**Knowledge Level**
Upon Completion of course the students will be able to		
CO -1	Gain practical knowledge in genetic engineering	**K1**
CO -2	Understand and perform the immunological experiments	**K2**
CO -3	Gain knowledge on immunotechnology	**K2**
CO -4	Operate bioinformatics softwares	**K3**
CO -5	Understand the principles and applications of bioprocess technology	**K5**

Relationship Matrix for CO, PO, PSO

Course Outcome (CO)	**Programme Outcome (PO)**					**Programme Specific Outcome (PSO)**					
	PO-1	**PO2**	**PO-3**	**PO-4**	**PO-5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**Mean**
CO-1	3	2	3	2	2	3	3	2	2	3	2.5
CO-2	2	2	2	1	2	2	3	3	2	3	2.2
CO-3	2	3	2	2	2	2	2	2	3	2	2.2
CO-4	2	2	3	3	2	2	2	2	2	2	2.2
CO-5	2	2	2	2	3	2	2	3	3	2	2.3
										Mean Overall Score	**2.28**
										Result	**High**

SEMESTER- II	
Title of The Course : REGENERATIVE MEDICINE	**Category of The Course :** Core Course
Course Code : P2R2BTDSE2:1	**Nature of The Skill :** Skill Development
Marks : CIA : 25 + Ext: 75 = 100	**Hrs / Week :** 5
Credits : 5	**Total Inst.Hrs :** 60

COURSE OBJECTIVES

- To teach students the fundamental principles for the design of engineered tissues
- The students will learn breadth and/or depth of the basic knowledge on regenerative medicine applying the thematic studies of stem cell technology and tissue engineering.
- To learn the unique properties of all stem cells. To know the potential uses of human stem cells.
- To learn the application of nanotechnology in biological system.
- To help the students to understand about nanomaterials and nanomedicine.

UNIT I: Introduction to tissue engineering **Hours: 12**

Current scope of development; use in therapeutics and in vitro testing Tissue Engineering and Cell-Based Therapies; Tissue Organization and Morphogenesis; Tissue Dynamics; Basic transplantation immunology and wound healing

UNIT II: Stem Cell technology **Hours: 12**

Introduction, Hematopoiesis ; Stem Cells and Lineages; ES cells; Pluripotent Stem Cells; Mesenchymal Stem Cells; Cell surface markers; Cell Isolation and Culture; Cell-Matrix & Cell-Cell Interactions; Cell Migration and Mechanics; induced Pluripotent stem cells (iPS)

UNIT III: Engineered Disease Models **Hours: 11**

In vivo cell & tissue engineering case studies: Artificial skin, Artificial blood vessels, Artificial pancreas, Artificial liver, Regeneration of bone, muscle, Nerve engineering

UNIT IV: Gene Therapy **Hours: 12**

Definition and salient features. Approaches for gene delivery; Ex vivo in Humans. Cystic Fibrosis (CF); Mechanism of CF pathogenesis and Gene therapeutic strategies. Human Genome Project-Features and applications. RNA Interference Technology - Mechanism of RNAi, siRNA Synthesis and delivery Strategies. Micro RNA. Applications of RNAi.

UNIT V: DNA-based Vaccines, Monoclonal Antibodies and Cytokines **Hours: 13**

Introduction. Attenuated vaccines, Subunit vaccines, newer vaccines; Peptide vaccines, Recombinant DNA (rDNA) vaccines, Edible vaccines. Monoclonal Antibodies: Targets in Therapy, Generation of MAbs, Recombinant MAbs, Immunotherapy using MAbs. Cytokines: Features and physiological Roles, Cytokines as Therapeutics agents,

TEXT BOOKS:

1. Fisher. Mikos Bronzino. 2007. Tissue Engineering. C.R.S Press.
2. Stem cell and Tissue Engineering, Editors Li, L Heureux and Elisseeff, World Scientific (2011), ISBN: 9789814317054
3. Stem Cell Engineering : Principles and Application Editors Artmann, Minger and Hescheler , Springer (2011), ISBN 978-3-642-11865-4
4. Tissue Engineering, Senior Editor Ulrich Martin , Springer (2009), ISBN: 978-3-642-32618-9
5. .Strachen and Read.2011. Human Molecular Genetics. 4th Edition. Garlan Science Publications.
6. Pearson and Benjamin. 2006. i. Genetics, 2nd edition. A Molecular Approach (Peter Russel)
7. David.P.C. Clark Nanitte J Pazdernik.2009. Biotechnology Applying the Genetic Revolution. Elsevier Academic Press.
8. Roland W. Herzog.2009. Gene therapy Immunology, Willey Blackwell Publications
9. Mountain. A, U.M Ney. Vol 5. 2010D.Schomburg. Biotechnology.2nd Edition. V.C.H & Wiley Company.
10. Kuby. Kindt. Goldsby. Osborne. 2007. Immunology. 6th Edition. W.H. Fruman & Company.

COURSE OUTCOMES

REGENERATIVE MEDICINE		**Course Code :** P1R2BTDSE2:1
S.No	**Course Outcome**	**Knowledge Level**
Upon Completion of course the students will be able to		
CO -1	Demonstrate an understanding of the clinical need for stem cell therapy and tissue engineering in regenerative medicine	**K1**
CO -2	Demonstrate knowledge of stem cell sources and their isolation, characterization	**K2**
CO -3	Demonstrate an understanding of the principle of tissue engineering using basic elements (stem cells, growth factors, biomimetic biomaterials and gene therapy) and their use for tissue engineering	**K3**
CO -4	Gauge the need for biomaterials and design, fabrication and used of the biomaterials *in vitro*, *in vivo* and clinical application	**K4**
CO -5	Develop the strategies of new drug discovery	**K5**

Relationship Matrix for CO, PO, PSO

Course Outcome (CO)	**Programme Outcome (PO)**					**Programme Specific Outcome (PSO)**					
	PO-1	**PO2**	**PO-3**	**PO-4**	**PO-5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**Mean**
CO-1	3	2	2	2	2	3	3	2	2	3	2.4
CO-2	2	2	3	1	2	2	2	2	2	2	2
CO-3	2	3	3	2	3	2	3	3	3	3	2.7
CO-4	3	2	3	3	2	2	2	2	2	2	2.3
CO-5	2	2	2	2	3	2	2	3	3	2	2.3
										Mean Overall Score	**2.34**
										Result	**High**

SEMESTER-II	
Title of The Course : GREEN BIOTECHNOLOGY	**Category of The Course :** Discipline Specific Elective
Course Code : P2R2BTDSE2:2	**Nature of The Skill :** Employability
Marks : CIA : 25 + Ext: 75 = 100	**Hrs / Week :** 05
Credits : 5	**Total Inst. Hrs :** 60

COURSE OBJECTIVES

- Aims to help the students to gain an advanced level of understanding the comprehensive components of plant biotechnology.
- The content of the course contribute for food security and human health towards sustainable agriculture.
- On top of technical insights into plant breeding, tissue culture, plant genes and genetic modification.
- This will have the overview of GM crops in the market and various applications like improved food quality and medicine.
- This course will also helps students carrers in plant related research, food industries and other plant based product development.

UNIT I **Hours: 12**

History of plant cell and tissue culture, Culture media; Various types of cultures: callus, cell suspension, nurse, root, meristem, *In vitro* differentiation: Organogenesis and somatic embryogenesis; Molecular basis of plant organ differentiation, Micropropagation - plant multiplication, hardening, transplantation, genetic fidelity, scale up and cost reduction, bioreactor, artificial seeds; Applications of tissue culture: Virus elimination by shoot tip culture.

UNIT II **Hours: 12**

In vitro pollination and fertilization, Wide hybridization and Embryo rescue, Androgenesis: Anther and pollen culture, Gynogenesis-ovule and ovary culture, dihaploids, their applications in genetics and plant breeding; GM crops and its applications.

UNIT III **Hours: 12**

Protoplast isolation and purification; Protoplast viability test; Protoplast culture and regeneration; Somatic hybridization - methods and applications; Cybrids, Somaclonal and gametoclonal variations, *In vitro* selection.

UNIT IV **Hours: 12**

Large-scale production of alkaloids and other secondary metabolites through cell culture techniques; high yielding cell lines, factors effecting production, Biotransformation, elicitors induced production, Hairy root culture and production of secondary metabolites. Immobilization of plant cells.

UNIT V **Hours: 12**

Plant Genetic resources, Germplasm conservation and cryopreservation, cryoprotectants, Gene bank, Some case studies on success stories on commercial application of plant tissue culture.

REFERENCES:

1. R.H.Smith, Plant Tissue Culture: Techniques and Experiments, Academic Press, San Diego. 1992.
2. S S Bhojwani and M K Razdan, Plant Tissue Culture, Elsevier Publ.
3. Adrian Slater, Nigel Scott and Mark Fowler, Plant Biotechnology: The genetic manipulation of plants, 1st Edition, Oxford University Press, 2003
4. Edited by BR Jordan, 2nd Edition, The Molecular Biology and Biotechnology of Flowering, CABI, 2006.
5. Jaiwal P K & Singh R P (eds) Plant Genetic Engineering Vol-1 to Vol. 9. Studium Press, USA

GREEN BIOTECHNOLOGY		Course Code :P1R2BTDSE2:2
S.No	Course Outcome	Knowledge Level
Upon Completion of course the students will be able to		
CO -1	Explains the basic methodology and applications of plant tissue culture.	**K1**
CO -2	Design experiments for functional characteisation of plant genes and to identify those suitable for creating agronomously important traits.	**K2**
CO -3	Conceptualize plant transformation,selection of desirable genes for crop improvement .	**K5**
CO -4	The students will understand the methods used for production of secondary metabolites	**K3**
CO -5	Students will also get usefull information about germ plasm conservation and preservation.	**K4**

Relationship Matrix for CO, PO, PSO

Course Outcome (CO)	**Programme Outcome (PO)**					**Programme Specific Outcome (PSO)**					
	PO-1	**PO2**	**PO-3**	**PO-4**	**PO-5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**Mean**
CO-1	3	2	2	2	2	3	3	2	2	3	2.4
CO-2	2	2	3	1	2	2	2	2	2	2	2
CO-3	2	3	3	2	3	2	3	3	3	3	2.7
CO-4	3	2	3	3	2	2	2	2	2	2	2.3
CO-5	2	2	2	2	3	2	2	3	3	2	2.3
										Mean Overall Score	**2.34**
										Result	**High**

SEMESTER-III	
Title of The Course : PLANT AND ANIMAL BIOTECHNOLOGY	**Category of The Course :** Core Course
Course Code : P3R2BTCC10	**Nature of The Skill :** SKILL BASED
Marks : CIA : 25 + Ext: 75 = 100	**Hrs / Week :** 05
Credits : 5	**Total Inst. Hrs :** 60

COURSE OBJECTIVES

- To study the details of plant cells, organ and tissue culture.
- To learn and gain the knowledge about the plant tissue culture for transgenic plant production
- To educate the theoretical knowledge on secondary metabolite production
- To get knowledge on secondary metabolite production to meet the global competence.
- To understand the principles of Animal cell culture and its applications.
- To understand and develop new technologies using molecular biology, manipulation and cell culture.

UNIT I: Plant Tissue Culture Techniques **Hours: 12**

Cell culture, suspension culture, organ culture, callus culture, embryo culture and applications of tissue culture, organogenesis - Somatic embryogenesis and Synthetic Seeds, Acclimatization. **Somatic Hybridization**: Protoplast isolation, fusion, regeneration of hybrids. cybridization, Somaclonal Variation- Haploid production – anther culture – pollen culture. Applications of plant tissue culture. Gene Bank – Germplasm and Cryopreservation.

UNIT II: Plant viral vectors **Hours: 12**

Gene transfer techniques to transform plant cells. Expression of induced genes. *Agrobacterium* mediated transgenesis and Protoplast fusion. Applications of Transgenic plants - RUBISCO, Chlorophyll binding proteins, heat shock genes , alcohol dehydrogenase (ADH) , Seed storage proteins in legumes and cereals, Enolpyruvyl shikimate phosphate Synthase (EPSPS) pathway.

UNIT III: Agricultural applications **Hours: 12**

Mechanism of Herbicide resistance, Bacterial resistance, Nematode Resistance, Pest resistance and Viral resistance with suitable examples and their applications in agriculture. Protease inhibitors, genes for other insecticidal secondary metabolities.

Stress and resistance: Fungal pathogen resistance- fungal toxin resistance. Abiotic and Biotic Stress resistance Production of Secondary metabolites, phytochemicals, antibodies, enzymes, pharmaceutical proteins in plants, plant derived drugs for medicine, Agroindustrial products

UNIT IV: Animal cell culture **Hours: 12**

Preparation and sterilization of various tissue culture media - natural and serum and protein free defined media. Role of carbon dioxide, serum, growth factors in cell culture. Primary and immortal cell culture. Development and maintenance of different cell lines, Lab based and large - scale culture, applications of animal cell culture. Cell synchronization.

UNIT V: Animal Viral Vectors **Hours: 12**

Biology and methods for the construction of Animal viral vectors - SV40, adeno virus, retro virus, vaccina virus, herpes virus, adeno associated virus and Baculo virus. Gene transfer in cells; physical, chemical and biological methods. Molecular Pharming for production of medical and diagnostic products- regulatory proteins, blood products, hormones. Recombinant vaccines (r-subunit vaccine, r-live vaccines, Anti-idiotipic, edible vaccines, HIV, Malarial vaccine), Interferon and growth factor and other therapeutic proteins. Transfection of animal cell lines, Transgenic animals and its applications.

TEXT BOOKS

1. Satyanarayanan, U. 2005. Biotechnology, Books and allied (p) Ltd., (Unit I-V)
2. Bhojwani, and Razdan, M.K . 2004. Tissue Culture Theory and Practice. (Unit I,II, V)
3. Chawla, H.S. Biotechnology in crop improvement. International Book distributing Company (1998). Unit (I-V)
4. Guptha, P.K. Elements of Biotechnology. Rastogi and Co. Meerut, (1996).
5. Animal biotechnology,R.Sasidhara ,2006, MJP Publishers.
6. Text book of Animal Biotechnology,Dr.P.Ramadass,Dr.S.Meera rani,2nd Edition 2002,MJP publishers.

REFERENCES

1. Fu, T-J., Singh, G. and Curtis, W.R. (Eds). 1999. Plant Cell and Tissue Culture for the Production of Food ingredients. Kluwer Academic/Plenum Press.
2. Hammond, J., McGarvey, P. and Yusibov, V. (Eds.). 2000. Plant Biotechnology. Springer Verlag.

3. Henry, R.J. 1997. Practical Application of plant Molecular biology. Chapman and hall.
4. Paul Christou and Harry Klee. 2004. Hand Book of Plant Biotechnology. Vol I& II. John Wiley & Sons. Ltd
5. Animal Biotechnology,M.M.Ranga, 2ndEdition,2003,Agrobios India.
6. Animal Cell Culture:A practical approach, Freshney, E.D., 2000, John Wiley Pub., NewYork.

COURSE OUTCOMES

PLANT AND ANIMAL BIOTECHNOLOGY	**Course Code :** P3R2BTCC10	
S.No	**Course Outcome**	**Knowledge Level**
Upon Completion of course, the students will be able to		
CO -1	The students will gain an insight into the concepts and techniques of plant biotechnology and its application to crop plants.	**K1**
CO -2	Able to apply the techniques to develop a standard protocol for Plant tissue culture.	**K2**
CO -3	The students will gain an insight into the concepts and techniques of animal cell culture and its wide industrial and medicinal applications.	**K5**
CO -4	The students are be able to gain knowledge on GMO and production of useful compounds	**K3**
CO -5	The students are be able to know the production of vaccine	**K4**

Relationship Matrix for CO, PO, PSO

Course Outcome (CO)	**Programme Outcome (PO)**					**Programme Specific Outcome (PSO)**					
	PO-1	**PO2**	**PO-3**	**PO-4**	**PO-5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**Mean**
CO-1	3	2	3	2	2	3	3	2	2	3	2.5
CO-2	2	2	2	1	2	2	3	3	2	3	2.2
CO-3	2	3	2	2	2	2	2	2	3	2	2.2
CO-4	2	2	3	3	2	2	2	2	2	2	2.2
CO-5	2	2	2	2	3	2	2	3	3	2	2.3
										Mean Overall Score	**2.28**
										Result	**High**

SEMESTER-III	
Title of The Course : ENVIRONMENTAL BIOTECHNOLOGY	**Category of The Course :** Core Course
Course Code : P3R2BTCC11	**Nature of The Skill:** Knowledge Based
Marks : CIA : 25 + Ext: 75 = 100	**Hrs / Week :5**
Credits :5	**Total Inst.Hrs :60**

COURSE OBJECTIVES

- The course explains the application of biotechnology in environment and to understand the energy sources, and remediation using biotechnology and its control.
- Students will get an idea about the hazards to our environment, solutions to protect and for sustainable development.
- This course is important in the era of industrialization leading to environmental hazards.
- Students to take up a career in tackling industrial pollution and also who is willing to take up the research in areas like development of biological systems.
- To learn the remediation of contaminated environments and for environment-friendly processes such as green manufacturing technologies and sustainable development.

UNIT I: Basic concepts of ecology **Hours: 12**

Components of Environment – Hydrosphere, lithosphere, atmosphere and biosphere – definitions with examples; Interaction of man and environment; Concept of habitat and ecological niches; Limiting factor; Energy flow, food chain, food web and tropic levels; Ecological pyramids and recycling. N.P.C and S cycles in nature. Population ecology.

UNIT II: **Environmental pollution** **Hours: 12**

Types, Causes and Effects of pollution - Air, Water, Land,Noise, Metal, Nuclear Hazards,Pesticides. Global Environmental Problems – Green House Effect, Acid rain, El Nino, Ozone depletion, deforestation, desertification, salination, biodiversity loss; chemical and radiation hazards.

Unit III: Environmental Waste Management **Hours: 12**

Sources, generation, classification & composition of solid wastes. Solid waste management methods - Sanitary land filling, Recycling, Composting, aerobic digestion, Vermicomposting, Incineration,

energy recovery from organic waste. Methods of Solid Waste Management,Hazardous Waste Control & Treatment,Hospital Waste Management, E- WasteManagement,Disaster Management,Primary, secondary, tertiary & advance treatment of sewage, various effluents (Distillery, tannery, paper pulp).Toxicity testing in waste water treatment plants.

UNIT IV: Bioremediation **Hours: 12**

Bioremediation – *In situ* and*ex situ* bioremediation. Bioremediation of soil & water contaminated with oil spills, heavy metals and detergents. Degradation of lignin and cellulose using microbes. Phyto-remediation. Degradation of pesticides and other toxic chemicals by microorganisms-degradation aromatic and chlorinates hydrocarbons and petroleum products.biodegradation of xenobiotics; bioremediation of contaminated soils and waste lands; radioactive product waste disposal.Oil biodegradation – Superbug, Bioleaching,Genetically Engineered Microorganisms (GEMs) in the environment.

UNIT V: **Production of Bio fuel &Environmental impact assessment** **Hours: 12**

Biogas technology, plant design, construction, operation, biogas form organic wastes, water weeds, landfills, microbiology of anaerobic fermentation.Introduction to environment impact analysis, Environmental impact statement and Environmental management plan.Impact assessment methodologies, Generalized approach to impact analysis. Restoration and rehabilitation technologies,Risk analysis-definition of risk, Environmental risk analysis, risk assessment and risk management, Bio accumulation – Bio magnification. Biological control. Principles of environment Impact. Assessment and environmental monitoring.

TEXT BOOKS

1. Environmental Biotechnology- Dilip Kumar MarKandey and NeelimnRajvaidya (APH publishing corporation, New Delhi)
2. Applied Biotechnology – LP Rema (MJP publishers, Chennai).
3. Environmental Impact Assessment-John Glasson.
4. A Textbook of Environmental Biology, S.K. Dubey, Wisdom Press (January 1, 2011)

REFERENCES

1. Environmental Biotechnology by Alan Scragg. Pearson Education Limited, England.
2. Environmental Biotechnology by S.N. Jogdand. Himalaya Publishing House.Bombay.
3. Wastewater Engineering – Treatment, Disposal and Reuse. Metcalf and Eddy, Inc., Tata Mc Graw Hill, NewDelhi
4. Environmental chemistry by A.K. De Wiley Eastern Ltd. NewDelhi

COURSE OUTCOMES

ENVIRONMENTAL BIOTECHNOLOGY		**Course Code : P3R2BTCC11**
S.No	**Course Outcome**	**Knowledge Level**
Upon Completion of course the students will be able to		
CO -1	Obtain knowledge on basic principles and technologies of decontamination of persistent organic pollutants (dangerous contaminants of the environment) mainly by means of the biological approaches i.e. using bioremediation etc.	**K1**
CO -2	The students will know about the principles and techniques underpinning the application of biosciences to the environment.	**K5**
CO -3	Explain the importance of environmental protection, diversity in environmental systems, processes and biotechnology	**K3**
CO -4	Understand and explain the importance of molecular approaches and control measures to protect environmental insults.	**K5**
CO -5	Understand existing and emerging technologies that are important in the area of environmental biotechnology in controlling various types of pollution and hazardous materials.	**K2**

Relationship Matrix for CO, PO, PSO

Course Outcome (CO)	**Programme Outcome (PO)**					**Programme Specific Outcome (PSO)**					
	PO-1	**PO2**	**PO-3**	**PO-4**	**PO-5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**Mean**
CO-1	3	2	2	2	2	3	3	2	2	3	2.4
CO-2	2	2	3	1	2	2	2	2	2	2	2
CO-3	2	3	3	2	3	2	3	3	3	3	2.7
CO-4	3	2	3	3	2	2	2	2	2	2	2.3
CO-5	2	2	2	2	3	2	2	3	3	2	2.3
										Mean Overall Score	**2.34**
										Result	**High**

SEMESTER- III	
Title of The Course : MEDICAL AND PHARMACEUTICALBIOTECHNOLOGY	**Category of The Course :** Core Course
Course Code : P3R2BTCC12	**Nature of The Skill :** Employability
Marks : CIA : 25 + Ext: 75 = 100	**Hrs / Week :** 5
Credits : 5	**Total Inst.Hrs :** 60

COURSE OBJECTIVES

- To understand the basic steps in the drug research, toxicological, pre-clinical and clinical studies.
- To update newer developments in pharmaceutical Biotechnology/emerging trends/ novel mechanisms of drug action etc.
- To study of inherited variation in drug response.
- Student's comprehensive information and insights in pharmaceutical biotechnology and the development of biopharmaceuticals in pharmaceutical industry.
- To gain an understanding in both scientific knowledge of designing and producing navel biologics, and business challenges in biopharmaceutical companies.

UNIT I: Introduction **Hours: 11**

Introduction and Scope of Pharma industry and biopharmaceuticals, Biotechnology and drug design: Development and economics, Preclinical studies and principles of process development, early prof -of- concept of chemical and biological entities, Orphan drugs. Provisions for and use of unlicensed medicines. Drug abuse and dependence, Prescription and non-prescription drugs.

UNIT II: Toxicology **Hours:15**

Introduction, Scope and importance: Basic concepts, Dose response-Fundamental issues intoxicology, LD50, ED50, PD50, Graphs and calculations. Dose response relationships forcumulative effects. Factors influencing dose response. Fate of toxicants and mechanism of actionof toxins, biotransformation of toxins and their clearance from the body; Toxicokinetic and Toxicity testing-*In-vitro* methods and *in-vivo* methods.

UNIT III: Drug Manufacture and Formulation **Hours: 11**

Basic concepts and applications, composition, preparation, physicochemical considerations in manufacture of current biotech products and herbal medicines. Quality control (QC), storage and stability of biotech products. Concept and testing of pre-formulations and their parameters. Tablets: compressed, granulation, coatings, pills, capsules. Parental preparations, Herbal extracts.

UNIT IV: Analysis of Pharmaceuticals **Hours: 11**

Validation techniques for pharmaceutical industries, pilot plant, scale-up techniques. Analyticalmethods and tests for various drugs-Alkalimetry, Acidimetry, Iodimetry, Aqueous and non-aqueous titration, Diazotization, Complexometry, Gravimetry, Potentiometry methods.Packaging techniques-Glass containers, plastic containers, film wrapper, bottle seals; QualityAssurance (QA) and Quality Control (QC).

UNIT V: Advanced pharmacology and Pharmacotherapy **Hours: 12**

Introduction and scope: Psychotherapeutic agents, Immuno-modulators, heavy metals and heavymetal antagonists, therapeutic gases. Free radical biology, Analgesics, Anti-inflammatory agents, Anti-Parkinson's drugs, CNS Stimulants. antioxidants and anti-toxicants.Pharmacotherapy; Special emphasis on vitamins, growth regulators, Growth factors, coldremedies, laxatives, analgesics, non-steroidal contraceptives, external antiseptics, antacids,biological, herbal products. Pharmacotherapy of migraine, Alzheimer's, TB, Diabetes and malesexual dysfunction. Hormone replacement therapy (HRT). Gene therapy – background,typesofgenetherapy(exvivo&invivo),Cell Adhesion-based therapy – integrins,inflammation,cancer&metastasis.Drug delivery – conventional& new approaches to drug delivery.

TEXT BOOKS

1. A Text Book of Modern Toxicology, Ernest Hodgson 2004, 3rd Edn. John Wiley & amp; Sons, Inc.
2. Industrial Pharmaceutical Biotechnology, Heinrich Klefenz,2002, Wiley-VCH Edn,

REFERENCES

1. Beier F.K, Crespi R.S and Straus T. Biotechnology and Patent protection, Oxford and IBH Publishing Co. New Delhi.
2. Jeffrey M. Gimble, Academia to Biotechnology, Elsevier Academic Press.

3. Rajmohan Joshi (Ed.). 2006. Biosafety and Bioethics. Isha Books, Delhi.
4. ShominiParashar, Deepa GoelIPR, Biosafety and Bioethics Pearson India 2013
5. Bioethics &BiosafteyBy Sateesh Mk (2008), Ik Publishers
6. Pharmacology and Pharmacotherapeutics – R.S.Satoskar, S.D. Bhandhakam and S.S. Alinapure

COURSE OUTCOMES

MEDICAL AND PHARMACEUTICAL BIOTECHNOLOGY		**Course Code :** P3R2BTCC12
S.No	**Course Outcome**	**Knowledge Level**
Upon Completion of course the students will be able to		
CO -1	Compare and contrast the specific pharmacology of the major classes of drugs, important distinctions among members of each class	**K1**
CO -2	Understand the medicinal and pharmaceutical importance of drug compounds	**K2**
CO -3	Students acquire a basic understanding about the drug research.	**K2**
CO -4	Apply the knowledge of pharmaceutical manufacturing in the production of biopharmaceuticals	**K3**
CO -5	Develop the strategies of new drug discovery	**K5**

Relationship Matrix for CO, PO, PSO

Course Outcome (CO)	**Programme Outcome (PO)**					**Programme Specific Outcome (PSO)**					
	PO-1	**PO2**	**PO-3**	**PO-4**	**PO-5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**Mean**
CO-1	2	2	2	1	2	3	3	2	2	3	2.2
CO-2	3	2	2	1	2	2	2	2	2	2	2.15
CO-3	2	3	2	2	2	2	3	2	3	2	2.3
CO-4	2	2	2	3	2	2	2	2	3	2	2.2
CO-5	2	2	2	2	3	2	2	3	3	2	2.3
										Mean Overall Score	**2.24**
										Result	**High**

SEMESTER-III	
Title of The Course : RESEARCH METHODOLOGY, IPR AND BIOETHICS	**Category of The Course :** Core Course
Course Code : P3R2BTCC13	**Nature of The Skill:** Skill Development
Marks : CIA : 25 + Ext: 75 = 100	**Hrs / Week :**5
Credits : 5	**Total Inst.Hrs :** 60

COURSE OBJECTIVES

- To impart scientific, statistical and analytical knowledge for carrying out research work effectively.
- To understand science frameworks for scientific inquiry
- To understand the various methods for conducting empirical research
- To examine trends and patterns in the use of various research methods
- To get knowledge to prepare research documents for publication
- To screen and select the correct journals to publish their research findings
- To articulate informed opinion about the value of empirical research**.**

Unit I: Biosafety **Hours: 12**

Biosafety regulations - Good laboratory practices - Good manufacturing practices in industry. Storage and disposal of hazardous wastes: radioactive materials – pathogenic strains. GMO's and their release in environment. Experimental protocol approvals -Levels of containment - Environmental aspects of biotech applications.

Unit II: Research in Biological Sciences **Hours: 12**

Research: research in Biological sciences- Objective – thrust areas and research priorities in Biotechnology to meet global competency- Origin of the research problem - Collection of literature: Internet –library – index card preparation - Experimental approach.

Unit III: Manuscript Preparation&Research Publications **Hours: 15**

Scientific communication: Introduction – manuscript preparation: Original – review – short communication. Thesis writing - Proof correction – symbols used for correction- preparation for Oral and poster presentation – preparation of Power Point presentations - communication skills for effective presentation.

Standards of journals: national and international – online and printed – paid and unpaid – peer reviewed journal – SCI journals – impact factor- h-index.

Research engines: Elsiever, Springer, Pubmed, Google scholar, Academic journals, online digital library- Social network for research community: Research gate, Research Pages, Frontiers Research Network, Elsevier Lab.

Unit IV: Research Proposal **Hours: 10**

Preparation of Project Proposal - Title, Abstract, Introduction – Rationale, Objectives, Methodology – Time frame and work plan – Budget and Justification – References

Writing research proposal for getting financial support – Sponsoring agencies – (DST, DBT, UGC, CSIR, ICMR, MoEF, MoEs, DRDO, DRDE, TNSCTE, TNSCST and NABARD).

UNIT V:Research Ethics & IPR **Hours: 11**

Ethics-ethical issues, ethical committees (human & animal); IPR- intellectual property rights and patent law, commercialization, copy right, royalty, trade related aspects of intellectual property rights (TRIPS); scholarly publishing- IMRAD concept and design of research paper, citation and acknowledgement, plagiarism, reproducibility and accountability.

TEXT BOOKS

1. Research methodology for biological science, Gurumani N, 2009, MIP publisher (Unit-I-III).
2. Essentials of Research Design & Methodology, Geofferey R, Marczyk, David De Mattea, David Festinga, 2005, John Wiley & Sons Publisher.
3. Free Study material for Unit- III: http://www.unom.ac.in/asc/Pdf/Session%201-%20Financial%20resources%20for%20research%20&%20development%20sponsored%20agencies.pdf

REFERENCES

1. Guide to publish a scienctifc paper, Ann M. Korner, 1996, Bioscript Press.
2. How to write and Publish a scientific paper, Rober A. Day, 1996, Cambridge Univeristy Press.

3. Bio-Statistics, Arora, PN and Malhan, PK, Himalaya Publishing House.
4. Fundamentals of Bio-Statistics Veer Bala Rastogi, Ane Book India.

COURSE OUTCOMES

RESEARCH METHODOLOGY, IPR and BIOETHICS		**Course Code : P3R2BTCC13**
S.No	**Course Outcome**	**Knowledge Level**
Upon Completion of course the students will be able to		
CO -1	Get knowledge on research proposal preparation and apply to the sponsoring agencies.	**K1**
CO -2	Benefits through socio-research networks.	**K5**
CO -3	Understanding of the history and methodologies of scientific research, applying these to recent published papers	**K3**
CO -4	Understanding and practicing scientific reading, writing, presentations	**K5**
CO -5	Appreciating scientific ethics through case studies.	**K2**

Relationship Matrix for CO, PO, PSO

Course Outcome (CO)	**Programme Outcome (PO)**					**Programme Specific Outcome (PSO)**					
	PO-1	**PO2**	**PO-3**	**PO-4**	**PO-5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**Mean**
CO-1	3	2	2	2	2	3	3	2	2	3	2.4
CO-2	2	2	3	1	2	2	2	2	2	2	2
CO-3	2	3	3	2	3	2	3	3	3	3	2.7
CO-4	3	2	3	3	2	2	2	2	2	2	2.3
CO-5	2	2	2	2	3	2	2	3	3	2	2.3
										Mean Overall Score	**2.34**
										Result	**High**

SEMESTER – III	
Title of The Course : PRACTICAL III COVERING CC10, CC11 and CC12	**Category of The Course : Core Course**
Course Code : P3R2BTCC14P	**Nature of The Skill :** Employability
Marks : CIA : 40 + Ext: 60 = 100	**Hrs / Week :** 05
Credits : 5	**Total Inst.Hrs :** 60

COURSE OBJECTIVES

- To understand the basic techniques of plant tissue culture
- To gain knowledge on separation and estimation of secondary metabolites
- To micropropagate commercially important plants
- To gain knowledge on animal cell culture
- To know the various techniques used in environmental and pharmaceutical biotechnology

PLANT BIOTECHNOLOGY

1. Preparation of plant tissue culture media and Organ culture (Shoot tip, nodal and leaf culture)
2. Callus culture: Initiation and regeneration
3. Anther culture for the production of haploids
4. Isolation, culture and fusion of protoplasts
5. Isolation of plant genomic DNA from plant by CTAB method
6. Synthetic seeds (Entrapment method)
7. Establishment and maintenance of suspension culture.
8. Separation and estimation of secondary metabolites β-carotene from carrot and anthocyanin from beetroot
9. Extraction & Separation of Chlorophyll A & B using Column Chromatography

ANIMAL BIOTECHNOLOGY

1. Preparation of Media for cell culture.
2. Trypsinization.
3. Cell viability test.
4. Cell counting.
5. Cytotoxicity testing
6. Animal Handling and care

ENVIRONMENTAL BIOTECHNOLOGY

1. Determination of total dissolved solids, BOD and COD of water sample
2. Estimation of Chromium in Industrial effluent by colorimetry
3. Estimation of Calcium & Chloride in water sample by titration method

4. Isolation of bacteriophages from sewage
5. Sludge analysis (a) Organic matter, (b) Nitrogen (c) Phosphorous (d) Potassium
6. Biodegradation of industrial aromatic compounds
7. Determination of Phosphate and nitrate from sewage samples
8. Microbial analysis of water-MPN technique.
9. Assessment of air quality – Enumeration of microbes.

MEDICAL AND PHARMACEUTICAL BIOTECHNOLOGY

1. Handling and Processing of a few Clinical Samples
2. Detection of drug resistant bacteria from clinical samples
3. Biochemical tests to differentiate various bacteria

REFERENCES

1. Animal Cell Culture: A practical approach, Freshney, E.D., 2000, John Wiley Pub., New York.
2. Plant Tissue culture theory & practical, Bhojwani and Razdan, M.K, 2004.
3. Tissue culture, methods and application, Hurse P.I. and Patterson.
4. Handbook of cell and Organ culture M.K Marchan, D, J. (2ndEd). Burgess Pub. Co., Minneapolis, USA. (1964).
5. Plant cell culture – A Practical Approach, Dixon, L.A. and R.A. Gonzales. , Revan Press, New York.
6. Plant Tissue Culture Methods and Applications in Agriculture, Quak, F. Academic Press, New York. (1981)

COURSE OUTCOMES

PRACTICAL III COVERING CC10, CC11 and CC12		**Course Code : P3R2BTCC14P**
S.No	**Course Outcome**	**Knowledge Level**
Upon Completion of course, the students will be able to		
CO -1	gain an insight into the techniques of plant biotechnology .	**K1**
CO -2	apply the techniques to develop a standard protocol for plant tissue culture.	**K2**

CO -3	gain knowledge about techniques of animal cell culture and its applications	**K5**
CO -4	understand the techniques underpinning the application of biosciences to the environment.	**K3**
CO -5	acquire a basic understanding about the drug research.	**K4**

Relationship Matrix for CO, PO, PSO

Course Outcome (CO)	Programme Outcome (PO)					Programme Specific Outcome (PSO)					
	PO-1	**PO2**	**PO-3**	**PO-4**	**PO-5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**Mean**
CO-1	3	2	3	2	2	3	3	2	2	3	2.5
CO-2	2	2	2	1	2	2	3	3	2	3	2.2
CO-3	2	3	2	2	2	2	2	2	3	2	2.2
CO-4	2	2	3	3	2	2	2	2	2	2	2.2
CO-5	2	2	2	2	3	2	2	3	3	2	2.3
										Mean Overall Score	**2.28**
										Result	**High**

SEMESTER – III	
Title of The Course : DIAGNOSTIC BIOTECHNOLOGY	**Category of The Course : Skill Enhancement Course**
Course Code : P3R2BTSEC1:1	**Nature of The Skill :** Skill Development
Marks : CIA : 25 + Ext: 75 = 100	**Hrs / Week :** 05
Credits : 3	**Total Inst.Hrs :** 60

COURSE OBJECTIVES

- To understand the basic principles and procedure followed in medical laboratory
- To develop a skill in that field for initiating the laboratory
- To understand the principles of hematology
- To get knowledge about clinical microbiology
- To know the detail knowledge about clinical diagnosis
-

UNIT I: Basic needs for Medical Laboratory **Hours: 12**

Introduction-Organization of Clinical laboratory-basic needs, functional components – Basic laboratory safety, Carcinogens, Chemicals and radioactive substances, Corrosive chemicals, Explosive chemicals, Firefighting equipment, First aid in laboratory accidents, Flammable chemicals-First Aid in laboratory accidents.

UNIT II: Human body and Human system **Hours: 11**

Introduction to Body organs and system, Physiology of Organs and system-Cardiovascular system, Respiratory system, excretory system. Units of measurement: The Metric system Preparation of reagent Solutions (Molar, Percentage)-Laboratory calculations.

UNIT III: Hematology **Hours: 12**

Introduction- Components of Blood and their functions-Human Blood group systems-Rh Blood group-Collection of Blood-transportation of Blood-storage of Blood-Haematopoietic system of the body-Determination of Haemoglobin concentration. Clinical haematology, Anticoagulants, Blood cell counts, Blood film examination.

UNIT IV: Clinical Microbiology **Hours: 11**

Microbiology: Laboratory Identification of infectious bacterial agents-Mycotic infections. Human parasites. Media used for culturing of Pathogens-Pathological features of Salomonella typhi, Vibrio cholerae and Mycobacterium tuberculosis. Emerging viruses and diseases.

UNIT V: Clinical Diagnosis **Hours: 14**

Urine analysis-Abnormal porphyrin metabolism, Blood in urine, Calcium in urine, Casts in urine, Chemical examination of urine, Semen analysis-Semen examination, Evaluation of infertility, Expensive examination of the female, Pregnancy test- Advantages of serum testing, Dipstick ICT pregnancy test, ELISA pregnancy test, ICT techniques for urine, Interpretation of test results, Material provided with the kit, Performance characteristics, Slide test for pregnancy.

REFERENCES

1. Kanai L.Mukherjee Medical laboratory technology vol I,II,and III
2. Basic and Practical Microbiology-Ronald M. Atlas, Mac.Milleen Company, New york.
3. Harper's illustrated biochemistry, David A. Bender et al., Mc Graw Hill, 27th edition 2006, New Delhi.

COURSE OUTCOMES

DIAGNOSTIC BIOTECHNOLOGY		**Course Code :** P3R2BSEC1:1
S.No	**Course Outcome**	**Knowledge Level**
Upon Completion of course the students will be able to		
CO -1	Assist physicians in the diagnosis and treatment of diseases	**K1**
CO -2	Get knowledge about prevention and diagnosis of diseases	**K4**
CO -3	Understand the principle to work in hospitals or doctors office	**K2**
CO -4	Diagnose the disease	**K5**
CO -5	Understand the principles of clinical sample collection	**K3**

Relationship Matrix for CO, PO, PSO

Course Outcome (CO)	**Programme Outcome (PO)**					**Programme Specific Outcome (PSO)**					
	PO-1	**PO2**	**PO-3**	**PO-4**	**PO-5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**Mean**
CO-1	3	2	1	1	3	3	2	2	1	3	2.1
CO-2	3	3	2	2	2	3	3	3	1	2	2.4
CO-3	3	3	2	1	3	3	3	3	1	3	2.5
CO-4	2	3	2	1	3	3	3	3	2	3	2.5
CO-5	3	3	2	2	2	2	3	3	2	2	2.4
										Mean Overall Score	**2.38**
										Result	**High**

SEMESTER – III	
Title of The Course : NANOBIOTECHNOLOGY	**Category of The Course :** Skill Enhancement Course
Course Code : P3R2BTSEC1:2	**Nature of The Skill :** Skill Development
Marks : CIA : 25 + Ext: 75 = 100	**Hrs / Week :** 05
Credits : 3	**Total Inst.Hrs :** 60

COURSE OBJECTIVES

- To learn the basics of nanobiotechnology
- To know the properties of nanomaterial
- To learn the methods of synthesis of nanoparticles
- To help the students to understand about nanocomposites
- Provide basic knowledge in the interface between chemistry, physics and biology on the Nano structural level with a focus on biotechnological usage.

UNIT I **Hours: 14**

Introduction and definition of Nanobiotechnology, History of Nanobiotechnology, Generations of Nanotechnology. Fundamental Concepts of Nanobiotechnology - Scope of Nanotechnology. Characteristics of Nanotechnology, Significance of Nanotechnology, Advantages and Limitations of Nanotechnology.

UNIT II **Hours: 14**

Introduction to Nanomaterials. Nanomaterials-Size and Shape. Dimensions of nanomaterials. Properties of nanomaterials-physical properties, mechanical properties, optical properties, electrical properties, magnetic properties, thermal properties and chemical properties. Quantum Dots, Types of biomaterials, Biodegradable polymers.

UNIT III **Hours: 14**

Synthesis of Nanomaterials- Top-Down Approach and Bottom-up Approach. Synthesis methods of nanoparticles- Physical methods (High energy ball milling, melt mixing physical vapour deposition, laser ablation, sputter deposition ,electric arc deposition and ion implantation), Chemical methods (Sol-Gel technique, microwave synthesis, hydrothermal synthesis, polyol synthesis, solvothermal method, micro emulsion technique, chemical vapour deposition, plasma enhanced chemical vapour deposition) and Biological methods. Nanocomposites- properties, types, synthesis and applications.

UNIT IV **Hours: 13**

Tools in Nano Biotechnology-Characterisation of nanomaterials-Physical characterisation (SEM, TEM, X-ray diffraction technique, Scanning probe microscopes, scanning tunneling microscope) and Chemical characterization (UV spectroscopy, X-ray photoelectron spectroscopy, Auger Electron Spectroscopy, Fourier Transforms infrared)

UNIT V **Hours: 13**

Nanotubes. Nanorod. Nanofiber. Nanomotors. Fullerenes for nanoscale drug. Measurement Techniques for nanomaterials. Applications of Nanotechnology in medicine, medical implants, cosmetics industry, textile industry, polymers and nanocomposite industry, agriculture, food industry, environment and health.

TEXT BOOKS

1. Nanotechnology, N Arumugam, Saras publication, 2016
2. A Text Book of Nanotechnology, Dr. M Arunmugam and Dr R Bhuvaneshwari, 2020

REFERENCES

1. Nanobiotechnology and Nanobiosciences, Claudio Nicolini, Pan Stanford Publishing Pte. Ltd, 2009.
2. Nanobiotechnology, Concepts, Applications and perspectives, C.M. Niemeyer and C.A. Mirkin, WILEY-VCH, Verlag Gmb H & Co, 2004.
3. Bionanotechnology, Lessons from Nature, S. David Goodsell, Wiley-Liss, Inc., 2004.
4. Nanotechnology in Drug Delivery, Melgardt M.deVilliers, Pornanong Aramwit, Glen S. Kwon, Springer-American Association of Pharmaceutical Scientists Press 2009.
5. Nanomedicine, Robert A. Freitas Jr. Volume I: Basic Capabilities, Landes Bioscience, 1999

COURSE OUTCOMES

NANOBIOTECHNOLOGY		**Course Code :** P3R2BTSEC1:2
S.No	**Course Outcome**	**Knowledge Level**
Upon Completion of course the students will be able to		
CO -1	Understand about the fundamentals of nanotechnology in biomedical and biological research.	**K1**
CO -2	Characterize the nanomaterials.	**K4**
CO -3	Understand the concepts of nanocomposites	**K2**
CO -4	Understand the mechanism of synthesis of nanomaterials	**K5**
CO -5	Acquire knowledge on application of nanoproducts in various industries	**K3**

Relationship Matrix for CO, PO, PSO

Course Outcome (CO)	**Programme Outcome (PO)**					**Programme Specific Outcome (PSO)**					
	PO-1	**PO2**	**PO-3**	**PO-4**	**PO-5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**Mean**
CO-1	3	2	1	1	3	3	2	2	1	3	2.1
CO-2	3	3	2	2	2	3	3	3	2	2	2.5
CO-3	3	3	2	2	3	3	3	3	2	3	2.7
CO-4	2	3	2	1	3	3	3	3	2	3	2.5
CO-5	3	3	2	2	2	2	3	3	2	2	2.4
										Mean Overall Score	**2.44**
										Result	**High**

SEMESTER-IV	
Title of The Course : ENTREPRENEURSHIP AND CAREER DEVELOPMENT IN BIOSCIENCES	**Category of The Course :** Generic Elective Course
Course Code : P4R2BTGEC1	**Nature of The Course :** Employability
Marks : CIA : 25 + Ext: 75 = 100	**Hrs / Week :** 05
Credits : 3	**Total Inst. Hrs :** 60

COURSE OBJECTIVES

- To learn the basics of Entrepreneurship
- To know the various kinds of entrepreneurs
- To develop knowledge on business ideas
- To understand about business environment
- To aware of business risks

Unit I **Hours: 12**

Introduction to Entrepreneurship – Meaning and concept of entrepreneurship; Need and Importance of entrepreneurship; The history of entrepreneurship development; Skills and characteristic of successful entrepreneurs; Entrepreneurship process; Factors impacting emergence of entrepreneurship; Role of entrepreneurship in economic development; Evolution and Growth of Entrepreneurship in India.

UNIT II **Hours: 12**

Types of Entrepreneurs; Ethical Entrepreneurship; Entrepreneurial Value: Values, Attitudes and Motivation; The entrepreneurial decision process, and role models; Self Assessment of Qualities; Skills, Resources and Dreams; Roles of society and family in the growth of an entrepreneur.

UNIT III **Hours: 12**

Generating business idea; Sources of new ideas; Methods of generating ideas; Creative problem solving; Opportunity recognition and assessment; Environmental scanning; Competitor and industry analysis; Feasibility study - Market feasibility, Marketing plan; marketing research for the new venture, Steps in preparing marketing plan; Technical/operational feasibility; Financial feasibility.

UNIT IV **Hours: 12**

Introduction to Business and its Environment; Components of a business plan; Meaning and significance of a business plan; Challenges of New Venture Strategies; Start-up Policy Framework and Incentives; drawing business plan; Preparing project report; Business Plan Preparation; Presenting business plan to investors; Execution of Business Plan; Business Incubation Centers.

UNIT V **Hours: 12**

Entrepreneurs - as problem solvers; Risk taking-Concept; types of business risks; Barriers to Entrepreneurship; Support structure for promoting entrepreneurship (various government schemes); Entrepreneurial Culture; Entrepreneurial Society; Women Entrepreneurship; Rural Entrepreneurship.

REFERENCES

1. Entrepreneurship - Hisrich, Robert D., Michael Peters and Dean Shepherded, , Tata McGraw Hill, ND.
2. Entrepreneurship - Brace R., and R., Duane Ireland, Pearson Prentice Hall, New Jersy (USA). 3. Entrepreneurship - Lall, Madhurima, and Shikha Sahai, Excel Book, New Delhi.
4. Entrepreneurship Development and Small Business Enterprises - Charantimath, Poornima, Pearson Education, New Delhi.
5. Entrepreneurship- New Venture Creation – David H. Holt

COURSE OUTCOMES

ENTREPRENEURSHIP AND CAREER DEVELOPMENT IN BIOTECHNOLOGY		**Course Code : P4R2BTGEC1**
S. No.	**Course Outcome**	**Knowledge Level**
Upon completion of the course, the students will be able to		
CO - 1	Understand about the fundamentals of Entrepreneurship	**K1**
CO - 2	Categorize the entrepreneurs	**K3**
CO - 3	Understand and develop business ideas	**K2**
CO - 4	Gain knowledge on business environment	**K4**
CO - 5	Acquire knowledge on various risks in business	**K4**

Relationship Matrix for CO, PO, PSO

Course Outcome (CO)	Programme Outcome (PO)					Programme Specific Outcome (PSO)					
	PO-1	**PO2**	**PO-3**	**PO-4**	**PO-5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**Mean**
CO-1	3	2	2	2	2	3	3	2	2	3	2.4
CO-2	2	2	3	1	2	2	2	2	2	2	2
CO-3	2	3	3	2	3	2	3	3	3	3	2.7
CO-4	3	2	3	3	2	2	2	2	2	2	2.3
CO-5	2	2	2	2	3	2	2	3	3	2	2.3
										Mean Overall Score	**2.34**
										Result	**High**

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