

PG & RESEARCH DEPT OF BIOTECHNOLOGY

M.Sc SYLLABUS

(With effect from the academic year 2023-2024 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

Proposed Course Structure based on TANSCHÉ and UGC - LOCF

(Choice Based Credit System)

(Applicable for the Candidates Admitted from Academic Year 2023-2024Onwards)

Sem	Course Code	Course Title	Hrs/ Week	Credit	Exam Hrs	Marks		
						Int.	Ext.	Total
I	P1R3BTCC1	Biochemistry	7	5	3	25	75	100
	P1R3BTCC2	Microbiology	7	5	3	25	75	100
	P1R3BTCC3P	Practical - I (Covering CC1,CC2)	6	4	6	40	60	100
	P1R3BTDSE1:1/1:2	Bioinstrumentation / Cell Signaling	5	3	3	25	75	100
	P1R3BTDSE2:1/2:2	Enzyme Technology/ Diagnostic Biotechnology	5	3	3	25	75	100
Total			30	20	-	-	-	500
II	P2R3BTCC4	Molecular Genetics	6	5	3	25	75	100
	P2R3BTCC5	Plant and Animal Biotechnology	6	5	3	25	75	100
	P2R3BTCC6P	Practical –II (Covering CC4,CC5)	6	4	6	40	60	100
	P2R3BTDSE3:1/3:2	Virology / Medical Bacteriology	4	3	3	25	75	100
	P2R3BTDSE4:1/4:2	Environmental Biotechnology / Pharmaceutical Technology /	4	3	3	25	75	100
	P2R3BTSEC1:1/1:2	Genetic Engineering / Food Technology	4	2	3	25	75	100
Total			30	22	-	-	-	600
III	P3R3BTCC7	Bioprocess Technology	6	5	3	25	75	100
	P3R3BTCC8	Immunology	5	5	3	25	75	100
	P3R3BTCC9	Bioinformatics	5	5	3	25	75	100
	P3R3BTCC10P	Practical –III (Covering CC7,CC8 & CC9)	6	5	6	40	60	100
	P3R3BTDSE5:1/5:2	Research Methodology/ Oncology	4	3	3	25	75	100
	P3R3BTSEC2:1/2:2	Nano Biotechnology/Bioethics,Biosafety IPR and System Biology	4	2	3	25	75	100
	P3R3BTINT	Internship	-	3	-	-	-	100
Total			30	28	-	-	-	700
IV	P4R3BTCC11	Stem cells technology	6	5	3	25	75	100
	P4R3BTCC12	Genomics and Proteomics	6	5	-	-	-	100
	P4R3BTCC13PW	Project Work	18	10	3	-	-	100
Total			30	20	-	-	-	300
Grand Total			120	90	-	-	-	2100

M.Sc. Biotechnology

Core Course - 1 BIOCHEMISTRY

SEMESTER – I	
Title of The Course: BIOCHEMISTRY	Category of The Course: CORE COURSE
Course Code: P1R3BTCC1	Nature of The Skill : Skill based
Marks : CIA : 25 + Ext: 75 = 100	Hrs / Week : 7
Credits : 5	Total Inst. Hrs : 105

Course Objectives:

1. The paper imparts a thorough knowledge on the basics of all the Biochemical concepts,
2. The students will understand the metabolic reactions and its regulation.
3. To understand the core concepts of metabolism
4. To teach the basics about the physiological processes of the body
5. The Students get idea about healthy and disease state.

SYLLABUS Core Course-1 BIOCHEMISTRY				
Unit	Content	Hours	COs	Cognitive level
I	pH, pK . acid, base .Buffers- Henderson- Haselbach equation , biological buffer system –Phosphate buffer system, protein buffer system, bicarbonate buffer system, amino acid buffer system and Hb buffer system. Water, Carbohydrates: Nomenclature, classification, structure, chemical and physical properties of carbohydrates. Metabolisms: glycogenesis, glycogenolysis, gluconeogenesis, pentose phosphate pathway	20	CO1	K1&k2
II	Lipids: Nomenclature, classification, structure, chemical and physical properties of fatty acids. Metabolisms: biosynthesis of fatty acids , triglycerols, phospholipids, glycol lipids. Cholesterol biosynthesis, bile acids and salt formation. Eicosanoids, sphingolipids and steroid hormones.	15	CO2	K1,K2 & K3

III	Bioenergetics – Concept of energy, Principle of thermodynamics, Relationship between standard free energy and Equilibrium constant, ATP as universal unit of free energy in Biological systems. Biological oxidation : Electron transport chain, oxidative phosphorylation, glycolysis, citric acid cycle, Cori's cycle, glyoxalate pathway. Oxidation of fatty acids- mitochondrial and peroxisomal β-oxidation , alpha and beta oxidation, oxidation of unsaturated and odd chain fatty acids, ketone bodies. Photosynthesis, urea cycle, hormonal regulation of fatty acids and carbohydrates metabolisms, Mineral metabolism	30	CO3	K1,K2 & K3
IV	Amino acids and Protein: Nomenclature, Classification, structure, chemical and physical properties of amino acids and proteins. Metabolisms: Biosynthesis of amino acids . Degradation of proteins, nitrogen metabolisms and carbon skeleton of amino acids. Over all inborn error metabolisms	20	CO4	K1,K2 & K3
V	Nucleic acids: Nomenclature, Classification, structure, chemical and physical properties of purine and pyrimidines. In de novo and salvage synthesis of purines, pyrimidine bases, nucleosides and nucleotides. Catabolisms of purines and pyrimidines bases. Synthetic analogues of nitrogenous bases	20	CO5	K1,K2 & K3
Total Hours		105		

Reference books:

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

Useful web sites:

- mcdB-webarchive.mcdB.ucsb.edu/.../biochemistry/.../website-tourf.htm
- www.biochemweb.org/
- <http://golgi.harvard.edu/biopages.html>

webarchive.mcdB.ucsb.edu/sears/biochemistry/info/website-

BIOCHEMISTRY		Course Code: P1R3BTCC1
S.No	Course Outcomes:	Knowledge Level
At the end of the Course, the Student will be able to:		
CO-1	To understand the basics of pH and related principles and carbohydrate metabolism.	K1
CO-2	To provide basic knowledge about lipid metabolism and related significance.	K2 & K3
CO-3	To enlighten the students on Bio-energetics and Biological oxidation pathways.	K4 & K5
CO-4	To update the knowledge on Amino acids and Protein.	K2
CO-5	To assess and appraise the role of Nucleic acids.	K6

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	M	M	M	S	S	S
CO2	M	M	M	S	S	M	S	S	M	M
CO3	M	M	M	S	S	S	S	M	M	M
CO4	S	S	S	M	M	M	S	S	M	S
CO5	M	M	M	S	M	S	M	M	S	S

PO – Programme Outcome, CO – Course outcome, S – Strong, M – Medium, L – Low

Core Course – 2
MICROBIOLOGY

SEMESTER – I	
Title of The Course: MICROBIOLOGY	Category of The Course: CORE COURSE
Course Code: P1R3BTCC2	Nature of The Skill : Skill based
Marks : CIA : 25 + Ext: 75 = 100	Hrs / Week : 7
Credits : 5	Total Inst. Hrs : 105

Course Objectives:

1. To provide a comprehensive knowledge on taxonomy of microorganisms
2. To understand the various microbial diversity
3. To know the growth of microbes & their harmful effects
4. To get a knowledge of microorganism's beneficial role in agriculture
5. To get an idea about the microbes impact in the environment.

SYLLABUS Core Course-2 MICROBIOLOGY				
Unit	Content	Hours	Cos	Cognitive level
I	History and microbial taxonomy: Major discoveries related to the field of microbiology: Antony Von Leeuwenhoek, Louis Pasteur, Robert Koch and Edward Jenner. Microbial taxonomy: Bacteria, viruses, fungi, algae and protozoa, Microbial diversity: Biovars, Serovars and Prions, Microbial growth and metabolism: Microbial growth: Growth curve, factors affecting growth, Microbial metabolism- Methanogenesis, acetogenesis and auxotrophs.	22	CO1 CO2	K1,K2 &K3

II	Microbial culture, identification, and control: Nutritional requirements for growth - Growth media and types, Pure culture techniques: Serial dilution and plating methods, Staining methods - Principles and types of staining (simple and differential), Identification of bacteria – Biochemical – IMVIC, 16s r RNA sequencing . Microscopy: principles and applications of Bright field, florescent and Scanning electron microscopes, Microbial growth control: Physical Methods – Heat, Filtration, Low Temperatures, High Pressure, Desiccation, Osmotic Pressure, Radiation; Chemical Methods	25	CO2 CO3 CO5	K2,K3,K5
III	Host microbe interaction and Epidemiology: Human microbiome; Skin, Gastrointestinal tract, Oral cavity, Lung. Symbiotic relationship of microbes: Symbiosis, Mutualism, Parasitism, Commensalism and endophyte. Epidemiology of microbes: causes, types and transmission of epidemic, endemic and pandemic diseases	16	CO1 CO3 CO4	K1,K2,K3
IV	Microbial Diseases: Microbial diseases - General characteristics, pathogenesis, laboratory diagnosis and control measures of Pandemic and Epidemic diseases: Tuberculosis, Leprosy, Cholera, Typhoid, COVID-19 , Yellow Fever, Flu, AIDS, Ebola, Zika Virus, Small Pox, Dengue, Chickungunya, Malaria, filariasis, Candidiasis, superficial mycosis	20	CO4 CO5	K4 &K5
V	Agricultural and Environmental Microbiology: Biological nitrogen fixation, free living, symbiotic nitrogen fixation, mechanism of Nitrogen, Biofertilizers - types and applications; Rhizosphere effect. Biogeochemical cycles-Carbon, Nitrogen, Sulphur and Phosphorous; Methanogenic bacteria Extremophiles- Thermophiles Acidophiles, Halophiles and alkalophiles; Biotechnological application of extremophiles	22	CO1 CO2 CO3	K4 & K5
Total Hours		105		

References

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

Web Sources

- <https://www.who.int/emergencies/diseases/managing-epidemics-interactive.pdf> ISBN 978-92-4-156553-0. <https://doi.org/10.3389/fmicb.2020.631736>

<https://www.agrimoon.com/wp-content/uploads/AGRICULTURAL-Microbiology.pdf>.

MICROBIOLOGY		Course Code: P1R3BTCC2
S.No	Course Outcomes:	Knowledge Level
At the end of the Course, the Student will be able to:		
CO-1	To understand the major discoveries of microbiology and describe microbial diversity, Microbial growth and metabolism.	K1
CO-2	To provide basic knowledge about microbial culture, identification of microbes, principle and working of microscopes and sterilization techniques	K2
CO-3	To enlighten the students on host microbe interaction and Epidemiology of microbial disease	K4
CO-4	To update the knowledge on epidemic and pandemic diseases.	K5
CO-5	To assess and appraise the role of novel microbes in environment and integrate them in specific innovative approaches.	K6

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	M	M	M	S	S	S
CO2	M	M	M	S	S	M	S	S	M	M
CO3	M	M	M	S	M	S	S	M	M	M
CO4	S	M	S	M	M	S	S	S	M	S
CO5	M	M	M	S	M	S	M	M	S	M

PO – Programme Outcome, CO – Course outcome S – Strong, M – Medium, L – Low (may be avoided)

Core Course - 3
PRACTICAL-I
(Biochemistry & Microbiology)

SEMESTER – I	
Title of The Course: PRACTICAL-I (Biochemistry, Microbiology)	Category of The Course: CORE COURSE
Course Code: P1R3BTCC3P	Nature of The Skill : Entrepreneurship based
Marks : CIA : 40 + Ext: 60 = 100	Hrs / Week : 6
Credits : 4	Total Inst. Hrs : 90

Course Objectives:

1. The practical will establish a basic study skills of Microbes.
2. To improve the student's ability to calculate the cell's count
3. To get an idea about the basic biochemistry analysis.
4. To get an knowledge about the isolation strategy of micro organisms.
5. To improve the micro organisms handling skill

SYLLABUS Core Paper-3 PRACTICAL-I				
Unit	Content	Hours	COs	Cognitive level

	(A) Biochemistry – Practical 1. Basic calculations in Biochemistry - Normality, Molarity, Molality percent solutions (v/v, w/v). 2. Calibration of pH meter 3. Transition interval of commonly used pH indicators 4. Preparation of biological buffer - phosphate buffer 5a. Extraction of Proteins from biological materials 5b Protein separation methods:-Ammonium sulphate Precipitation, 5c. Membrane Dialysis, 5d. SDS PAGE 6. Urea-SDS PAGE for separation of low molecular weight proteins 7. Estimation of Proteins by Lowry's method	50	CO1 CO2 CO3 CO4 CO5	K3 & K4
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	8. Estimation of Proteins by Biuret method 9. Estimation of Proteins by Bradford method 10. Estimation of RNA by orcinol method 11. Estimation of DNA by diphenylamine method 12. Estimation of Carbohydrate by Anthrone method 13 Purity check of DNA & RNA by UV Spectrophotometry - A260/280 14. Separation of amino acids by Paper Chromatography 15. Separation of sugars by Paper Chromatography 16. Separation of amino acids by Thin layer chromatography 17. Separation of sugars by Thin layer chromatography 18. Thermal Denaturation of DNA and UV absorption studies Demo Experiments 1. Gel permeation chromatography, 2. Affinity chromatography, 3. Ion.exchange chromatography 4. Western blotting 5. PCR			
	(B) Microbiology-Practicals 1. Sterilization of glassware using dry heat- hot air oven 2. Sterilization of media using moist heat - autoclave 3. Filter sterilization 4. Liquid media preparation- nutrient broth 5. Solid media preparation- SDA plates 6. Preparation of Agar slants 7. Streak plate method 8. Pour plate method 9. Spread plate method 10. Enumeration of total count of the bacteria	40	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5 & K6

11. Isolation of microbes from soil 12. Isolation of microbes from water 13. Isolation of microbes from air 14. Isolation of microbes from plant surface. 15. Isolation of pure culture of <i>E.coli</i> , 16. Isolation of pure culture of <i>Aspergillus niger</i> , 17. Isolation of pure culture of <i>Streptomyces</i> . 18. Gram staining and morphological characterization of microbes. 19. Negative staining of bacteria 20. Determination of growth curve of bacteria – <i>E.coli</i> 21. IMVIC test of enteric bacteria Demonstration 16srRNA sequencing			
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Reference

1. Introduction to Practical Biochemistry, E.F Plummer Mu, Plummer Tata McGraw-Hill Education, 1998.
2. Principles and techniques of biochemistry and molecular biology (7th ed). Keith Wilson (editor), John Walker (editor), Cambridge University Press, 2010.
3. Microbiology- A Laboratory manual P. Gunasekaran . New age publications, New delhi, 1995.
4. Laboratory exercise of Microbiology, J.P. Harley and L.M. Prescott, 5th Edition, the McGraw-Hill companies, 2002.
5. Microbiology: A Laboratory Manual, J.G. Cappuccino and N. Sherman, Addison-Wesley, 2002.
6. Laboratory Manual of Experimental Microbiology ,R.M. Atlas, A.E. Brown and L.C. Parks, 1995. Mosby, St. Louis, 2002.
7. Laboratory manual in General Microbiology, N. Kannan, Panima publishers.
8. Bergey's Manual of Determinative Bacteriology. Ninth Edition J.G. Holt, N.R. Krieg, Lippincott Williams, Wilkin publishers, 2000.

PRACTICAL-I (Biochemistry and Microbiology)		Course Code: P1R3BTCC3P
S. No	Course outcomes	Knowledge Level
On successful completion of the course the students will be able to		
CO 1	Illustrate the basic biochemistry procedures	K1
CO 2	Study the methods of estimation of biomolecules	K2
CO 3	Isolate and identify microbes from various sources	K3
CO 4	Critically analyze the isolated biomolecules	K5
CO 5	Characterize microbes	K6

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	S	S	S	S	M	S
CO2	S	S	M	S	S	S	S	M	S	M
CO3	S	S	S	S	S	M	S	S	S	S
CO4	S	M	S	S	M	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	M	S

PO – Programme Outcome, CO – Course outcome S – Strong, = 3, M – Medium, L – Low (may be avoided)

Discipline Specific Elective-1:1**BIOINSTRUMENTATION**

SEMESTER – I	
Title of The Course: BIOINSTRUMENTATION	Category of The Course: DISCIPLINE SPECIFIC ELECTIVE COURSE
Course Code: P1R3BTDSE1:1	Nature of The Skill : Entrepreneurship based
Marks : CIA : 25 + Ext: 75 = 100	Hrs / Week : 5
Credits : 3	Total Inst. Hrs : 75

Course Objectives:

1. To get an idea about the basic instruments in the laboratory
2. To understand about the cell culture separation techniques
3. To get an knowledge of chromatographic techniques
4. To improve their skill in handling microscopes
5. To observe the basic concepts of radioisotopes.

SYLLABUS Discipline Specific Elective 1:1 BIOINSTRUMENTATION				
Unit	Content	Hours	COs	Cognitive level
I	Microscopic Techniques: Principles and Applications: Compound, Light, Stereo, Phase Contrast, Fluorescent Microscopy, Scanning and Transmission Electron Microscopy, Scanning Electron Microscopy, Atomic Force Microscopy, Confocal Microscopy, FRET and Flow Cytometry.	14	CO1	K1 & K2
II	Centrifugation: pH meter, Principle and Applications of various types of centrifugation, Sedimentation Coefficient, Svedberg unit, RCF, Density Gradient Centrifugation. Chromatography Techniques: Principle and Application of Paper Chromatography, TLC, Gel Filtration Chromatography, Ion Exchange Chromatography, Affinity Chromatography, GC & HPLC.	16	CO2	K1, K2,K3

III	Electrophoretic Techniques: Principle and Application of Agarose Gel Electrophoresis, 2D-gel Electrophoresis, PAGE- NATIVE & SDS PAGE, Iso-electric Focusing, High resolution Electrophoresis, Immuno Electrophoresis (Immunofixation EP,), ELISA, RIA, Southern, Northern and Western Blotting. Electro blotting, PCR and RT-PCR, Microarray (DNA, Proteins)	17	CO3	K1, K2 & K3
IV	Spectroscopic Techniques: Theory and Application of UV and Visible Spectroscopy, Fluorescence Spectroscopy, Mass Spectroscopy, IR Spectroscopy NMR, ESR, Atomic Absorption Spectroscopy, X- ray Spectroscopy, Laser Spectroscopy and Raman Spectroscopy	15	CO4	K1,K2 & K3
V	Radio-isotopic Techniques: Introduction to Radioisotopes, Uses and their Biological Applications, Radioactive Decay – Types and Measurement , Principles and Applications of GM Counter, Solid and Liquid Scintillation Counter, Autoradiography, RIA, Radiation Dosimetry, Health effects of Radiations.	13	CO5	K1,K2 & K3
Total Hours		75		

Reference books

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

- Holcapek, M., Byrdwell, Wm. C. 2017. Handbook of Advanced Chromatography /Mass Spectrometry Techniques, Elsevier

BIOINSTRUMENTATION		Course Code: P1R3BTDSE1:1
S.No	Course Outcomes	Knowledge Level
At the end of the Course, the Students will be able to		
CO-1	Know the various types of Microscopic techniques	K2
CO-2	Impart understanding on centrifugal instruments and techniques	K3
CO-3	Separation of Biomolecules	K4
CO-4	Analytical methods on Spectroscopic Analysis	K5
CO-5	Understand the application and Detection on Bioinstrumentation	K6

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	M	M	M	S	S	S
CO2	M	M	M	S	S	M	S	S	M	M
CO3	M	M	M	S	S	S	S	M	M	M
CO4	S	S	S	M	M	M	S	S	M	S
CO5	M	M	M	S	M	S	M	M	S	S

PO – Programme Outcome, CO – Course outcome, S – Strong, M – Medium, L – Low

Discipline Specific Elective-1:2**Cell Signaling**

SEMESTER – I	
Title of The Course: CELL SIGNALING	Category of The Course: DISCIPLINE SPECIFIC ELECTIVE COURSE
Course Code: P1R3BTDSE1:2	Nature of The Skill : Skill based
Marks : CIA : 25 + Ext: 75 = 100	Hrs / Week : 5
Credits : 3	Total Inst. Hrs : 75

Course Objectives:

1. To give a thorough knowledge on the basics of all the cell to cell contacts
2. To know about the cellular receptors and their importance.
3. The student will get an idea about host & parasite communication.
4. To understand the core concepts of cell signaling
5. To get a detailed knowledge in the mechanism of cell signaling.

SYLLABUS Discipline Specific Elective 1:2 CELL SIGNALING				
Unit	Content	Hours	COs	Cognitive level
I	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.	15	CO1	K1 & K2
II	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	17	CO2	K1, K2,K3

II	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.			
III	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)	16	CO3	K1, K2 & K3
IV	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 .	15	CO4	K1,K2 & K3
V	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	12	CO5	K1,K2 & K3
Total Hours		75		

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 University Press.35

NET REFERENCES

- <http://www.landesbioscience.com/journals/BioArchitecture/about/>
- <http://expmed.bwh.harvard.edu/main/labs.html>
- <http://www.unc.edu/depts/salmlab/mafia/mafia.html>

CELL SIGNALING		Course Code: P1R3BTDSE1:2
S.No	Course outcomes	Knowledge Level
At the end of the Course, the Student will be able to		
CO-1	To impart basic knowledge about cells & their matrix Systems	K1
CO-2	To understand the importance of proteins in signaling	K2
CO-3	To be effective in hormones and growth factors in signaling system of plants & animals	K2
CO-4	To acquire knowledge on cancer cell communication & their genes.	K3
CO-5	To gain the knowledge of interaction between host and parasites.	K4

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	M	M	M	S	S	S
CO2	M	M	M	S	S	M	S	S	M	M
CO3	M	M	M	S	S	S	S	M	M	M
CO4	S	S	S	M	M	M	S	S	M	S
CO5	M	M	M	S	M	S	M	M	S	S

PO – Programme Outcome, CO – Course outcome, S – Strong, M – Medium, L – Low

Discipline Specific Elective - 2:1**ENZYMOLOGY**

SEMESTER – I	
Title of The Course: ENZYMOLOGY	Category of The Course: DISCIPLINE SPECIFIC ELECTIVE COURSE
Course Code: P1R3BTDSE2:1	Nature of The Skill : Skill based
Marks : CIA : 25 + Ext: 75 = 100	Hrs / Week : 5
Credits : 3	Total Inst. Hrs : 75

Course Objectives:

1. The subject imparts knowledge on the fundamentals of enzyme structure and its kinetics
2. To obtain a basic knowledge about the proximity of enzymes
3. The students will understand about the functions of enzymes
4. The students get an idea about the co-enzymes in detail.
5. To impart knowledge on industrial application of enzymes

SYLLABUS Discipline Specific Elective 2:1 ENZYMOLOGY				
Unit	Content	Hours	Cos	Cognitive level
I	Introduction to enzymes, Classification, nomenclature and general properties like effects of pH, substrate and temperature on enzyme catalysed reactions. Extraction Isolation and purification of enzymes by precipitation, centrifugation, chromatography and electrophoresis and liquid-liquid extraction methods	14	CO1 & CO5	K3 & K5
II	Kinetics of catalysed reaction : Single substrate reactions, bisubstrate reactions, concept of Michaelis - Menten, Briggs Haldane relationship, Determination and significance of kinetic constants, Limitations of Michaelis-Menten Kinetics, line weaver burk plot, Hanes wolf equation, Eadie hoofstee equation ,Inhibition of enzyme activity	15	CO1 CO2 CO5	K3 & K5

III	Enzyme catalysis: enzyme specificity and the concept of active site, determination of active site. Stereospecificity of enzymes. Mechanism of catalysis: Proximity and orientation effects, general acid-base catalysis, concerted acid - base catalysis, nucleophilic and electrophilic attacks , catalysis by distortion, metal ion catalysis	16	CO1 CO3	K3 & K4
IV	Theories on mechanism of catalysis.-Mechanism of enzymes action: mechanism of action of lysozyme, chymotrypsin, carboxypeptidase and DNA polymerase. Multienzymes system , Mechanism of action and regulation of pyruvate dehydrogenase and fatty acid synthetase complex	13	CO1 CO4	K3, K4 & K6
V	Coenzyme action. Enzyme regulation: General mechanisms of enzyme regulation, Allosteric enzymes, sigmoidal kinetics and their physiological significance, Symmetric and sequential modes for action of allosteric enzymes. Reversible and irreversible covalent modification of enzymes, Immobilized enzymes and their industrial applications.Clinical and industrial applications of enzymes, Enzyme Engineering	17	CO1 CO5	K3,K4, K5 & K6
Total Hours		75		

Reference Books

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

Useful Websites

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

<http://www.aetltd.com/tech/applications.html>

Course outcomes:

ENZYMOLGY		Course Code: P1R3BTDSE2:1
S.No	Course outcomes	Knowledge Level
At the end of the Course, the Student will be able to		
CO-1	Explain the basics of enzyme nomenclature and properties	K1 & K2
CO-2	Classify and Recognize the native and immobilized enzyme	K4
CO-3	Examine the equations of steady state kinetics	K5
CO-4	Assess extraction and downstream processing of enzymes	K6
CO-5	Compile the uses of enzymes and design enzymes for Industrial and Clinical application	K6

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	M	M	M	S	S	S
CO2	M	M	M	S	S	M	S	S	M	M
CO3	M	M	M	S	S	S	S	M	M	M
CO4	S	S	S	M	M	M	S	S	M	S
CO5	M	M	M	S	M	S	M	M	S	S

PO – Programme Outcome, CO – Course outcome, S – Strong, M – Medium, L – Low

Discipline Specific Elective - 2:2
DIAGNOSTIC BIOTECHNOLOGY

SEMESTER – I	
Title of The Course: DIAGNOSTIC BIOTECHNOLOGY	Category of The Course: DISCIPLINE SPECIFIC ELECTIVE COURSE
Course Code: P1R3BTDSE2:2	Nature of The Skill : Entrepreneurship based
Marks : CIA : 25 + Ext: 75 = 100	Hrs / Week : 5
Credits : 3	Total Inst. Hrs : 75

Course Objectives:

- The subject will understand the concept of chemical usage and its first aid practices.
- To imparts knowledge on the fundamentals of Clinical Laboratory and its importance
- The student will be provided with a basic knowledge of Anatomy
- The student will get an knowledge about the hematopoietic system of human body.
- To understand about the functions of human body

SYLLABUS Discipline Specific Elective 2:2 DIAGNOSTIC BIOTECHNOLOGY				
Unit	Content	Hours	Cos	Cognitive level
I	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.	15	CO1 CO5	K3 & K5
II	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.	13	CO1 CO2 CO5	K3 & K5

III	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.	14	CO1 CO3	K3 & K4
IV	Microbiology: Laboratory Identification of infectious bacterial agents-Mycotic infections. Human parasites. Media used for culturing of Pathogens-Pathological features of Salmonella typhi, Vibrio cholerae and Mycobacterium tuberculosis. Emerging viruses and diseases.	15	CO1 CO4	K3, K4 & K6
V	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.	18	CO1 CO5	K3,K4, K5 & K6
Total Hours		75		

REFERENCES

1. Kanai L.Mukherjee Medical laboratory technology vol I,II,and III
2. Basic and Practical Microbiology-Ronald M. Atlas, Mac.Millan 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: P1R3BTDSE2:2
S.No	Course outcomes	Knowledge Level
At the end of the Course, the Student will be able to		
CO-1	To understand the basic principles and procedure followed in medical laboratory	K1
CO-2	To develop a skill in that field for initiating the laboratory	K3
CO-3	To understand the principles of hematology	K2
CO-4	To get knowledge about clinical microbiology	K4
CO-5	To know the detail knowledge about clinical diagnosis	K5

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	S	S	S	S	M	S
CO2	S	S	M	S	S	S	S	M	S	M
CO3	S	S	S	S	S	M	S	S	S	S
CO4	S	M	S	S	M	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	M	S

PO – Programme Outcome, CO – Course outcome S – Strong, = 3, M – Medium, L – Low (may be avoided)

M. Sc Biotechnology

Core Course - 4 MOLECULAR GENETICS

SEMESTER - II	
Title of The Course: MOLECULAR GENETICS	Category of The Course: CORE COURSE
Course Code: P2R3BTCC4	Nature of The Skill : Skill based
Marks : CIA : 25 + Ext: 75 = 100	Hrs / Week : 6
Credits : 5	Total Inst. Hrs : 90

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 the outline of the development steps in sex determination.

SYLLABUS Core Paper - 4 MOLECULAR GENETICS				
Unit	Content	Hours	COs	Cognitive level
I	Genes and chromosomes, Colinearity of Genes and Proteins, Genetic code , Identification of DNA as the genetic material. The complexity of eukaryotic genome (introns, exons, repetitive DNA sequence, gene duplication and pseudogenes). DNA markers - VNTR, STR, microsatellite , SNP and their detection techniques	15	CO1	K1,K2 & K3

II	Replication of DNA, Gene expression and regulation in prokaryotes and eukaryotes. Mutation: Spontaneous and virus induced mutation, Radiation induced mutation. Ionizing radiation , UV radiation. Chromosomal Abnormalities and associated genetic diseases, Techniques in the study of chromosomes and their applications, Recombination – models	15	CO2	K1,K2 &K3
III	DNA Damage and Repair -Internal and external agents causing DNA damages 3.2. DNA damages (Oxidative damages, Depurinations, Depyrimidinations , O6-methylguanines, Cytosine deamination, single and double strand breaks) 3.3. Mechanisms of DNA damage (transition, transversion, frameshift, nonsense mutations) 3.4. Repair mechanisms (Photo reactivation, excision repair, mismatch repair, post replication repair, SOS repair) 3.5. Discovery: Early experiments of McClintock in maize . Insertion sequences in prokaryotes. Complex transposons (ex. Tn3, Tn5, Tn9 and Tn10). Mechanisms, control consequences and application of transposition by simple and complex elements	20	CO3	K1,K2 &K3
IV	Allele frequencies and genotype frequencies, Random mating population, Hardy-Weinberg principle , complications of dominance, special cases of random mating – multiple alleles, different frequencies between sexes (autosomal and X-linked) inbreeding, genetics and evolution, random genetic drift, Karyotyping and usefulness of chromosomes in understanding Genetic variation, Genetics of eukaryotes gene linkage and chromosome mapping.	20	CO4	K1 &K2

V	Extra chromosomal heredity: Biology of Plasmids, their discovery, types and structure of F.RTH. <i>col</i> factors and Ti – Replication and partitioning, Incompatibility and copy number control-natural and artificial plasmid transfer and their applications- Human Genome Project , Genomics and Modern methodologies in understanding genome.	20	CO5	K1,K2 & K3
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References:

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

MOLECULAR GENETICS		Course Code : P2R3BTCC4
S.No	Course Outcome	Knowledge Level
Upon completion of course, the students will be able to		
CO-1	To acquire good knowledge about the molecular mechanisms of gene expression and understand the theories behind the organization and functions of genetic material in the living world.	K1,K2 & K3
CO -2	Identify and distinguish genetic regulatory mechanisms at different levels and explain the processes behind mutations and other genetic changes and study various chromosomal abnormalities.	K1,K2 & K3
CO -3	Make the students understand different range of DNA damage and range of their tools for their detection an.	K1,K2 & K3
CO -4	Learn the concepts of the transposons and their applications.	K1 & K2
CO -5	Detects the Allele frequencies and genotype frequencies in populations and describe the concepts behind the theory of evolution	K1,K2 & K3

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

Core Course - 5
PLANT AND ANIMAL BIOTECHNOLOGY

SEMESTER - II	
Title of The Course: PLANT AND ANIMAL BIOTECHNOLOGY	Category of The Course: CORE COURSE
Course Code: P2R3BTCC5	Nature of The Skill : Skill based
Marks : CIA : 25 + Ext: 75 = 100	Hrs / Week : 6
Credits : 5	Total Inst. Hrs : 90

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.

SYLLABUS Core Paper-5 PLANT AND ANIMAL BIOTECHNOLOGY				
Unit	Content	Hours	COs	Cognitive level
I	Introduction of plant tissue culture, composition of media, Micropropagation , organogenesis, somatic embryogenesis, haploid and triploid production, protoplast isolation and fusion, hybrid and cybrid, synthetic seed production. Secondary metabolites in plants - Phytochemicals- Glycosides and Flavonoids; Anthocyanins and Coumarins - Lignans, Terpenes, Volatile oils and Saponins; Carotenoids and Alkaloids: biogenesis, therapeutic applications	15	CO1 CO5	K1,K2 &K3

II	Plant Transformation Direct transformation by electroporation and particle gun bombardment. Agrobacterium, Ti plasmid vector. Theory and techniques for the development of new genetic traits, conferring resistance to biotic and abiotic. Plant engineering towards the development of enriched food products, plant growth regulators; Molecular Marker aided breeding: RFLP maps, Linkage analysis, RAPD markers, STS Mirco satellite, SCAR, SSCP, QTL, Map based cloning and Molecular marker assisted selection.	15	CO1 CO2 CO5	K1,K2 & K5
III	Animal health disease diagnosis, hybridoma technique, monoclonal antibodies, application of probes for disease diagnosis of existing and emerging animal diseases. Prophylaxis - Vaccines, Oral vaccines DNA Vaccines in animal disease. Cell culture: primary and established culture; organ culture; tissue culture	20	CO1 CO3 CO5	K4 & K5
IV	Disaggregation of tissue and primary culture; cell separation, Slide and coverslip cultures, flask culture, test tube culture techniques, cell synchronization, cryo preservation. Scaling up of animal cell culture, cell line and cloning micromanipulation and cloning, somatic cell cloning. Karyotyping; measuring parameters for growth, measurement of cell death, apoptosis and its determination, cytotoxicity assays	20	CO4 CO5	K2,K3,K4 & K5

V	Nuclear magnetic resonance methods of monitoring cell metabolism culturing animal cells in fluidised bed reactors. Application of animal cell culture for in vitro testing of drugs, in production of human and animal viral vaccines and pharmaceutical proteins. Culture Scale up and mass production of biologically important compounds. Harvesting of products, purification and assays. Transgenic animals: Production and application; transgenic animals in livestock improvement, transgenic animals as model for human diseases; Stem Cells- Properties, Types, Therapy, Prospects and Ethics in stem cell research.	20	CO5	K3,K4 & K6
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Reference Books

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

Course outcomes:

PLANT AND ANIMAL BIOTECHNOLOGY		Course Code : P2R3BTCC5
S.No	Course Outcome	Knowledge Level
Upon completion of course, the students will be able to		
CO-1	To impart theoretical knowledge on various techniques of plant biotechnology like tissue culture, plant genetic transformation and their application in industries.	K1,K2 & K3
CO-2	Importance of secondary metabolites and production in plants.	K1,K2 & K5
CO-3	To develop concepts, principles and processes in animal biotechnology.	K4 & K5
CO-4	Concept and different types in Animal Cell Culture and animal cell lines.	K2,K3,K4 & K5
CO-5	Use of molecular biology techniques genetically engineer the animals to improve sustainability, productivity and suitability for pharmaceutical and industrial applications.	K3,K4 & K6

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

Core Course - 6

PRACTICAL - II (Covering CC4 & CC5)

Molecular Genetics & Plant and Animal Biotechnology

SEMESTER - II	
Title of The Course: PRACTICAL - II (Molecular Genetics & Plant and Animal Biotechnology)	Category of The Course: CORE COURSE
Course Code: P2R3BTCC6P	Nature of The Skill : Employability
Marks : CIA : 40 + Ext: 60 = 100	Hrs / Week : 6
Credits : 4	Total Inst. Hrs : 90

COURSE OBJECTIVES

- To know the fundamental aspects of human heredity.
- To make them understand the factors which influence the inheritance.
- To understand the basic techniques of plant tissue culture
- To gain knowledge on separation and estimation of secondary metabolites
- To know in outline the development steps in sex determination.

SYLLABUS Core Paper-6 PRACTICAL-II				
Unit	Content	Hours	COs	Cognitive level
A	(A) Molecular Genetics - Practical 1. Isolation of DNA from bacteria 2. Isolation of DNA from plants 3. Isolation of DNA from animal tissue 4. Isolation of DNA from blood 5. Plasmid DNA isolation. 6. Agarose gel electrophoresis of DNA 7. Transfer of DNA from gel – Southern Blotting 8. Isolation of RNA 9. Glyoxal denatured Agarose gel electrophoresis of RNA 10. Formaldehyde denatured Agarose gel electrophoresis of RNA 11. Urea denatured Agarose gel electrophoresis of RNA 12. Transfer of RNA from gel – Northern Blotting 13. Restriction digestion of DNA 14. Radiation induced genetic damage assessment 15. Chemical induced genetic damage assessment. 16. Preparation of metaphase chromosomes from blood	40	CO1 CO2 CO3 CO4 CO5	K3,K4 &K5

B	(B) Plant and Animal Biotechnology - Practicals: 1. Plant tissue culture media preparation 2. Plant tissue culture sterilization techniques. 3. Generation of Callus from leaf 4. Generation of Callus from root 5. Generation of Callus from bud 6. Generation of Callus from shoot apex 7. Maintenance of callus culture. 8. Cell suspension culture 9. Anther culture 10. Pollen culture 11. Embryo culture. 12. Isolation of plant protoplast 13. Culture of plant protoplast. 14. Protoplast viability test. 15. Localization of nucleus using nuclear stain. 16. Agrobacterium culture maintenance and isolation of plasmid DNA. 17. Mass culture of Chlorella /Spirulina 18. Introduction to Animal Cell culture: Procedure for handling cells and medium. 19. Cleaning and sterilization of glassware and plastic tissue culture flasks 20. Preparation of tissue culture media 21. Preparation of sera for animal cell culture 22. Preparation of single cell suspension from chicken liver (Primary cell culture). 23. Trypsinization of established cell culture. 24. Cell counting and viability - staining of cells (a) Vital Staining (Trypan blue, Erythrosin (b) Giemsa staining. 25. MTT Assay	50	CO1 CO2 CO3 CO4 CO5	K3,K4 & K5
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REFERENCES:

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.
4. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., (2008) Molecular Biology of the Gene (VI Edition.). Cold Spring Harbour Lab. Press, Pearson Pub.
5. Animal Cell Culture: A practical approach, Freshney, E.D., 2000, John Wiley Pub., New York.
6. Plant Tissue culture theory & practical, Bhojwani and Razdan, M.K, 2004.
7. Tissue culture, methods and application, Hulse P.I. and Patterson.
8. Handbook of cell and Organ culture M.K Marchan, D, J. (2nd Ed). Burgess Pub. Co., Minneapolis, USA. (1964).
9. Plant cell culture – A Practical Approach, Dixon, L.A. and R.A. Gonzales. , Revan Press, New York.

Course outcomes:

PRACTICAL-II (Molecular Genetics & Plant and Animal Biotechnology)		
Course Code : U5R2BTSEC2:1		
S.No	Course Outcome	Knowledge Level
Upon completion of course, the students will be able to		
CO-1	Isolate and identify microbes from various sources.	K3,K4 &K5
CO-2	Characterize microbes.	K3,K4 & K5
CO-3	Examine Plant and Animal cells and their functions	K3,K4 &K5
CO-4	Assess extracted DNA, RNA and protein for rDNA technology	K3,K4 & K5
CO-5	to study cloning tools	K3,K4 &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

Discipline Specific Elective - 3:1

VIROLOGY

SEMESTER - II	
Title of the Course: VIROLOGY	Category of The Course: DISCIPLINE SPECIFIC ELECTIVE COURSE
Course Code: P2R3BTDSE3:1	Nature of The Skill : Skill based
Marks : CIA : 25 + Ext: 75 = 100	Hrs / Week : 4
Credits : 3	Total Inst. Hrs : 60

Course Objectives:

- Contrast differences in virus architecture and classification.
- To understand the viral diagnostic and detection methods.
- Distinguish characteristics of normal cells and virus-infected cells.
- Explain and apply methods used in research and diagnosis of viral diseases.
- Describe cellular and therapeutic antiviral strategies and social stigmas against infected individuals.

SYLLABUS DISCIPLINE SPECIFIC ELECTIVE -3:1 VIROLOGY				
Unit	Content	Hours	COs	Cognitive level
I	General Virology: Structure of viruses: Enveloped and non-enveloped viruses, Capsid symmetries-icosahedral, polyhedral and helical, structural proteins- matrix proteins and lipoproteins, viral genomic organization and replication- types of nucleic acids, protein-nucleic-acid interactions and genome packaging, Virus related structures-viroids and prions. Cultivation of viruses: In vivo, In vivo, Ex vivo/In vitro. Cytopathic effect-pock forming unit.	10	CO1 CO5	K1,K2 &K3
II	Viral diagnostic and detection methods: Sample processing-enrichment and concentration, Direct methods of detection-light microscopy (inclusion bodies), electron microscopy, Immuno diagnosis, hemagglutination, Complement fixation, neutralization, Western blot, Radioactive Immuno precipitation Assay (RIPA), Flow Cytometry and Immuno histochemistry. Nucleic acid-based diagnosis: Nucleic acid hybridization, PCR, microarray and nucleotide sequencing, LINE probe assay.	10	CO1 CO2 CO5	K1,K2 & K5

III	Bacterio phages and plant viruses: Bacterio phage: Morphology, genome organization, classification-Lifecycle-Lytic and Lysogenic Cycle, Head and tailphages- T4phage-phage- Filamentous Bacteriophages-174-M13,phage therapy for control of bacterial poultrydiseases. Viral Disease in Plants: Histological, physiological and cytological changes in infected plants, Behavior of viruses in plants, Methods for detection of plant viruses, Transmission of plant viruses through vectors-insects, nematodes and fungi.	10	CO1 CO3 CO5	K4 & K5
IV	Clinical virology: Pathogenesis, clinical symptoms, epidemiology and prophylaxis of DNA Viruses - pox virus, Herpes Virus, Adenovirus, Hepatitis Virus. RNA Viruses- Picorna Virus, Orthomyxo Virus, Rabies Virus, HIV. Oncogenic viruses; Virus-induced cell transformation and oncogenesis, Mechanism of cell transformation by tumor viruses,	15	CO4 CO5	K2,K3,K4 & K5
V	Viral vaccines and anti-viral drugs: Viral vaccines, conventional vaccines-killed and attenuated, Modern vaccines-DNA vaccines, recombinant DNA/protein vaccines, subunits vaccines, peptide vaccines, anti-idio type vaccines, edible vaccines, immuno modulators (cytokines), adjuvants to increase immunogenicity of vaccines. Antivirals: Interferons, 21 designing and screening for antivirals, mechanisms of action, anti retrovirals-mechanism of action and drug resistance.	15	CO5	K3,K4 & K6

Reference Books

- Virology principles and application John Carter and Venetia Saunders (2007) John Wiley and Sons publishers.
- Principles of Virology 4th edition Jane Flint.
- Real –Time PCR: Current technology and applications 1st edition (2009) edited by Julie Logan *et al.*,
- Analytical techniques in DNA sequencing edited by Brian K. Nunnally
- Medical Microbiology: with student consult by Patrick R. Murray Ph.D. (Author), Ken S. Rosenthal PhD Saunders; 7th edition.
- Antiviral Agents, Vaccines and Immunotherapies. Stephen K. Tryg. October 2004. Marcel Dekker.

Discipline Specific Elective - 3:2**MEDICAL BACTERIOLOGY**

SEMESTER- II	
Title of the Course: MEDICAL BACTERIOLOGY	Category of The Course: DISCIPLINE SPECIFIC ELECTIVE COURSE
Course Code: P2R3BTDSE3:2	Nature of The Skill : Skill based
Marks : CIA : 25 + Ext: 75 = 100	Hrs / Week : 4
Credits : 3	Total Inst. Hrs : 60

Course Objectives

- Acquire Knowledge on collection, transportation and processing of various kinds of clinical specimens.
- Explain morphology, characteristics and pathogenesis of bacteria.
- Discuss various factors leading to pathogenesis of bacteria.
- To understand the handling and maintenance of laboratory animals.
- To know the significance of Nosocomial, infections and Zoonotic diseases

SYLLABUS DISCIPLINE SPECIFIC ELECTIVE -3:2 MEDICAL BACTERIOLOGY				
Unit	Content	Hours	COs	Cognitive level
I	Classification of medically important bacteria, Normal flora of human body, Collection, transport, storage and processing of clinical specimens, Microbiological examination of clinical specimens, antimicrobial susceptibility testing. Handling and maintenance of laboratory animals - Rabbits, guinea pigs and mice.	10	CO1 CO5	K1,K2 &K3
II	Morphology, classification, characteristics, pathogenesis, laboratory diagnosis and treatment of diseases caused by species of <i>Staphylococci</i> , <i>Streptococci</i> , <i>Pneumococci</i> , and <i>Neisseriae</i> .	10	CO1 CO2 CO5	K1 & K5

III	Morphology, classification, characteristics, pathogenesis, laboratory diagnosis and treatment of diseases caused by species of <i>Bacillus</i> , <i>Corynebacteria</i> , <i>Mycobacteria</i> and <i>Clostridium</i> .	10	CO1 CO3 CO5	K4 & K5
IV	Morphology, classification, characteristics, pathogenesis, laboratory diagnosis and treatment of diseases caused by <i>Enterobacteriaceae</i> members, <i>Yersinia</i> , <i>Pseudomonas</i> , <i>Vibrio</i> , <i>Mycoplasma</i> , <i>Helicobacter</i> , <i>Rickettsiae</i> , <i>Chlamydiae</i> and <i>Bordetella</i> .	15	CO4 CO5	K2,K3,K4 & K5
V	Morphology, classification, characteristics, pathogenesis, laboratory diagnosis and treatment of diseases caused by <i>Francisella</i> ., <i>Spirochaetes</i> - <i>Leptospira</i> , <i>Treponema</i> and <i>Borrelia</i> . Nosocomial, zoonotic and <i>opportunistic infections</i> - prevention and control.	15	CO5	K3,K4 & K6

Reference Books

1. (2017).Orient Longman, Hyderabad.
2. Greenwood, D., Slack, R. B. and Peutherer, J. F. (2012) Medical Microbiology, (18th Edition). Churchill Livingstone, London.
3. Finegold, S. M. (2000) Diagnostic Microbiology, (10th Edition). C.V. Mosby Company, St. Louis.

Text Book

1. Salle A. J. (2007). Fundamental Principles of Bacteriology. (4th Edition). Tata McGraw-Hill Publications.
2. Collee J.C. Duguid J.P. Foraser, A.C, Marimon B.P, (1996). Mackie & McCartney Practical Medical Microbiology. 14thedn, Churchill Livingston.
3. Cheesbrough M. (2006). District Laboratory Practice in Tropical countries.- Part 22ndedn.Cambridge University Press.
4. Topley and Wilson's. (1998). Principles of Bacteriology.9th edn. Edward Arnold, London.

MEDICAL BACTERIOLOGY		Course Code : P2R3BTDSE3:2
S. No.	Course Outcome	Knowledge Level
Upon completion of the course, the students will be able to		
CO - 1	Collect, transport and process of various kinds of clinical specimens.	K1,K2 &K3
CO - 2	Analyze various bacteria based on morphology and pathogenesis.	K1 & K5
CO - 3	Discuss various treatment methods for bacterial disease.	K4 & K5
CO - 4	Acquiring theoretical knowledge for handling and maintenance of laboratory animals.	K2,K3,K4 & K5
CO - 5	Employ various methods detect Nosocomial and Zoonotic diseases	K3,K4 & K6

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	2	3	2	2	2	2	2	2.3
CO-5	2	2	2	2	2	2	3	3	3	2	2.3
Mean Overall Score											2.34
Result											High

Discipline Specific Elective - 4:1
ENVIRONMENTAL BIOTECHNOLOGY

SEMESTER - II	
Title of The Course: ENVIRONMENTAL BIOTECHNOLOGY	Category of The Course: DISCIPLINE SPECIFIC ELECTIVE COURSE
Course Code: P2R3BTDSE4:1	Nature of The Skill : Skill based
Marks : CIA : 25 + Ext: 75 = 100	Hrs / Week : 4
Credits : 3	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.

SYLLABUS/ DISCIPLINE SPECIFIC ELECTIVE - 4:1 ENVIRONMENTAL BIOTECHNOLOGY				
Unit	Content	Hours	COs	Cognitive level
I	Environment: Basic concepts and issues; Environmental management and Conservation, Environmental Laws & Agencies involved in conservation. Environmental Pollution: Types of pollution & its control strategies -Air pollution, Soil pollution, Water pollution, Oil pollution & Radioactive pollution	10	CO1 CO5	K2

II	Biofilm Kinetics: Completely mixed biofilm reactor- Soluble microbial products and inert biomass-Special-case biofilm solution. Reactor types:- batch reactor - continuous-flow stirred-tank reactor- Plug-flow reactor. Engineering design of reactors- Reactors in series	10	CO1 CO2 CO5	K3
III	Waste water management, source of waste water, Waste water treatment- physical, chemical and biological treatment. Microbiology of Waste water; Aerobic and anaerobic process, BOD and COD.	10	CO3	K4
IV	Toxicity: Types and Test for evaluating Toxicity. Biosensors, Biomonitoring of toxic materials .Biomagnification, Biomining and Biofuels	15	CO4	K5
V	Bioremediation; <i>In-situ and Ex-situ</i> Bioremediation of contaminated soils and waste land; Microbiology of degradation of Xenobiotics in environment; Pesticides, Surfactants, Degradative plasmids. Solid waste: Composting, Vermiculture and methane production.	15	CO5	K6

Reference Books:

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

Useful Websites:

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

ENVIRONMENTAL BIOTECHNOLOGY

Course Code : P2R3BTDSE4:1

S.No	Course Outcome	Knowledge Level
Upon completion of course, the students will be able to		
CO-1	Explain various waste management methods	K2
CO-2	Classify potential methods of biodegrading organic pollutants.	K3
CO-3	Examine the techniques involved in remediation of polluted environments	K4
CO-4	Assess types of pollution & its control	K5
CO-5	Compile biotechnological approaches to degrade xenobiotic compounds	K6

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

Discipline Specific Elective - 4:2
PHARMACEUTICAL BIOTECHNOLOGY

SEMESTER - II	
Title of The Course: PHARMACEUTICAL BIOTECHNOLOGY	Category of The Course: DISCIPLINE SPECIFIC ELECTIVE COURSE
Course Code: P2R3BTDSE4:2	Nature of The Skill : Employability
Marks : CIA : 25 + Ext: 75 = 100	Hrs / Week : 4
Credits : 3	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 novel biologics, and business challenges in biopharmaceutical companies.

SYLLABUS DISCIPLINE SPECIFIC ELECTIVE - 4:2 PHARMACEUTICAL BIOTECHNOLOGY				
Unit	Content	Hours	COs	Cognitive level
I	Introduction to concepts and technologies in pharmaceutical biotechnology and industrial applications, Biosensors - Working and applications of biosensors in pharmaceutical Industries; Pharmacology and Ethnopharmacology : Scope, applications and Importance.	10	CO1	K1

II	Scientific, technical and economic aspects of vaccine research and development, Preparation of bacterial vaccines, toxoids, viral vaccine and antitoxins, Storage conditions and stability of vaccines, Recombinant DNA technology, Application of rDNA technology and genetic engineering in the production of: (i) Interferon (ii) Vaccines - hepatitis- B (iii) Hormones – Insulin, Brief introduction to Protein Engineering, Therapeutic proteins, Production of Enzymes- General consideration – Amylase, Catalase, Peroxidase, Lipase, Protease, Penicillinase, Methods of enzyme immobilization and applications	10	CO2	K3 & K4
III	Hybridoma technology - Production, Purification and Applications, Formulation of biotech products - Rituximab, Introduction to Microbial biotransformation and applications, Study of the production of – penicillins, citric acid, Vitamin B12, Glutamic acid and Griseofulvin Somatic gene therapy, Xenotransplantation in pharmaceutical biotechnology, Large scale production fermenter design and its various controls, Bio safety in pharmaceutical industry	10	CO3	K2
IV	Pharmacological activity of Plant drugs, Plant Chemicals in modern pharmacology; biochemistry and pharmacology of atropine, caffeine, ephedrine, opioids, taxol, vinca alkaloids, synthetic substitutes for therapeutically active plant constituents; drug improvement by structure modification and bio-transformation. Criteria for pharmacological evaluation of drugs.	15	CO4	K2 & K4

V	Clinical Pharmacology, Drug therapy, therapeutic situation, benefits and risk of use of drugs, Mechanism of drug action, Therapeutic efficacy, Therapeutic index, tolerance, dosage forms and routes of drug action , factors affecting drug action; Adverse Drug reactions and drug poisoning-classification and causes of ADR; principle clinical manifestations and treatment of ADR, General principles of management of drug poisoning; antidotes, classification of drugs.	15	CO5	K1,K2 &K5
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Reference Books:

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

Useful Websites:

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

Course outcomes:

PHARMACEUTICAL BIOTECHNOLOGY		Course Code : P2R3BTDSE4:2
S.No	Course Outcome	Knowledge Level
Upon completion of course, the students will be able to		
CO-1	Explain the basic components of pharmaceutical and biotechnology industry and methods and applications of biosensor	K1
CO-2	Describe the Scientific, technical and economic aspects of vaccine & rDNA technology	K3 & K4
CO-3	Describe the basic concepts of protein Engineering, therapeutic proteins and enzyme immobilization techniques	K2
CO-4	Describe the concepts of hybridoma technology, microbial biotransformation and microbial bio-transformed products	K2 & K4
CO-5	Explain the basic components of somatic gene therapy, Xeno-transplantation and fermenter and bio safety methods	K1,K2 &K5

Relationship Matrix for CO, PO, PSO

Course	Programme Outcome (PO)					Programme Specific Outcome (PSO)					
Outcome (CO)	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

Skill Enhancement Course - 1:1 GENETIC ENGINEERING

SEMESTER - II	
Title of The Course: GENETIC ENGINEERING	Category of The Course: SKILL ENHANCEMENT COURSE
Course Code: P2R3BT SEC1:1	Nature of The Skill : Skill based
Marks : CIA : 25 + Ext: 75 = 100	Hrs / Week : 4
Credits : 2	Total Inst. Hrs : 60

COURSE OBJECTIVES:

- To illustrate creative use of modern tools and techniques for manipulation and analysis of genomic sequences.
- To expose students to application of recombinant DNA technology in biotechnological research.
- To train students in strategizing research methodologies employing genetic engineering techniques.
- Understand the concepts, introduction of genetic engineering, introduction about restriction enzymes, ligases, polymerases, vectors, their types, sources and their roles in genetic engineering.
- Knowledgeable in basic techniques of molecular biology and their applications in various aspects.

SYLLABUS Skill Enhancement Course - 1:1 GENETIC ENGINEERING				
Unit	Content	Hours	COs	Cognitive level
I	Gene cloning. Genetic engineering tools. Nucleic acid manipulating enzymes. Promoters, Selectable markers and reporters used in r DNA technology . Restriction digestion, Ligation, Transformation, Selection of Recombinants. Construction of gene libraries	10	CO1	K1,K2, K5

II	<i>E.Coli</i> vectors - pBR322 and its derivatives; Cloning vectors for gram negative bacteria - ColE1, p15A, R1, IncPa, pSC101; Lambda bacteriophage vectors, filamentous phages, Cosmids, Phasmids, Phagemids. Cloning in gram positive bacteria (<i>Bacillus subtilis</i>)	10	CO2	K2,K3, K4
III	Cloning in yeast <i>Saccharomyces cerevisiae</i> . Life cycle and types of vectors; Eukaryotic vectors. SV40 (molecular genetics and expression); Specialized cloning vector for cDNA; Synthesis of specific RNA in vitro; Vectors for cloning promoters and terminators; vectors with adjustable copy number	10	CO4	K3,K4 &K6
IV	Nucleic acid hybridization techniques; Molecular probes (Types of probes and its construction); probe labeling. Nick translation, End labeling and Random primer labeling. Polymerase chain reaction and its variants; DNA fingerprinting; DNA sequencing first generation sequencing methods (Maxam and Gilbert sequencing, Sangers Dideoxy sequencing, Pyrosequencing, PCR based sequencing and hybridization sequencing).Second generation sequencing methods	15	CO4	K3,K4,K5 & K6
V	Site directed mutagenesis; DNA microarray; chromosome walking and jumping. Molecular techniques in prenatal diagnosis gene therapy, Transgenic animals (knockout mice) and plants (Flavr savr tomato), Pharmaceutical products (Vaccine, Humulin, etc), Crop improvement. Pesticide resistance, herbicide resistance, transgenic animals and GM foods; Modern Concepts in Genetic Analysis.	15	CO5	K3,K4,K5 & K6

Reference Books:

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

GENETIC ENGINEERING	Course Code : P2R3BT SEC1:1
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S.No.	Course Outcome	Knowledge Level
Upon completion of course, the students will be able to		
CO-1	Understanding the basic steps of gene cloning and the role of enzymes and vectors responsible for gene manipulation, transformation and genetic engineering.	K1,K2, K5
CO-2	Getting detailed knowledge of gene transfer methods and identifying suitable hosts for cloning.	K2,K3, K4
CO-3	Acquiring theoretical knowledge in the techniques, tools, and application and safety measures of genetic engineering.	K3,K4 &K6
CO-4	Describes the genome mapping and sequencing and methods for gene therapy.	K3,K4,K5 & K6
CO-5	Elucidate different techniques involved in genetic engineering	K3,K4,K5 & K6

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

[illegible]

Skill Enhancement Course - 1:2 FOOD TECHNOLOGY

SEMESTER – II	
Title of The Course: FOOD TECHNOLOGY	Category of The Course: SKILL ENHANCEMENT COURSE
Course Code: P2R3BTSEC1:2	Nature of The Skill : Employability
Marks : CIA : 25 + Ext: 75 = 100	Hrs / Week : 4
Credits : 2	Total Inst. Hrs : 60

COURSE OBJECTIVES:

- To provide knowledge on various processing technologies of food and food products, preservation, long term storage and food safety aspects.
- To know about the structure, principles and applications of Bioreactors.
- To adds information about the role of microorganisms in many food industries both in production and spoilage processes.
- To create awareness among the students about the food quality analysis and the role of government organizations involved in food quality control.
- To encode the importance processing, preservation and packaging of many food products

SYLLABUS Skill Enhancement Course -1.2 FOOD TECHNOLOGY				
Unit	Content	Hours	Cos	Cognitive level
I	Planning, Organisation and setting of Food testing laboratory and laboratory safety Understand the requirements for setting up a laboratory for the legal defensibility of analytical data. The ideal structure design, environment, layout for microbiological testing and Air handling etc., Introduction about accreditation, Different accreditation bodies (NABL, APLAC, ILAC), Requirements for ISO/IEC 17025:2017 , documentation, pre-requisites for accreditation, management requirements, technical requirements, measurement of traceability, Laboratory safety : Personnel and laboratory hygiene, emergency planning, general hazards in a food laboratory, safety equipment, storage of chemicals, acids, flammables etc, handling and biological spills and waste disposal .	10	CO1	K2,K3,K4

II	Principles of Food Preservation technology Heat: Principles of Heat transfer, Blanching, Pasteurization, Heat sterilization, thermal extrusion, cooking. Water Removal: Forms of Water in Foods, Sorption of water in foods, Water activity, drying and evaporation technology. Temperature reduction: Chilling, Freezing, Radiation: Ionizing Radiation, Microwave, Use of chemicals: Class-I & Class-II preservatives, smoke other chemical additives, New non-thermal methods: High hydrostatic pressure, modified atmosphere, high intensity pulsed electric fields, intense pulsed light, oscillating magnetic fields, hurdle technology, ultrasonic and ohmic heating etc.	10	CO2	K2 & K3
III	Principles of Food Packaging technology Effect of environment on food stability: light, oxygen, water, temperature, sensitivity to mechanical damage and attack by biological agents, Different packaging materials used for food packaging and their properties including barrier properties, strength properties, optical properties: Glass, metals, paper, plastics, biodegradable and edible films and coatings aseptic packaging and combinations, Selection of packaging material and design for various food commodities including fresh produce (Fruits and vegetables), milk and milk products (dairy), cereal, pulses, oil, meat, fish, poultry, water and processed foods, Evaluation of quality and safety of packaging materials-different testing procedures, Function of packaging: Protective packaging and active packaging smart and intelligent packaging, Newer packaging technologies-CAP/MAP packaging aseptic processing and packaging, irradiated packaging, retort pouch and microwaveable packaging.	15	CO3	K2,K3 & K4

IV	Food Microbiology and testing Introduction of Food microbiology: Classification and nomenclature of microorganisms. Morphology and structure of microorganisms in foods (yeast and Molds, Bacterial cells viruses), Important genera of mold, yeast, bacteria (Gram positive and Gram negative, facultative aerobic and anaerobic, endospore forming bacteria and non-sporulating bacteria), Bacterial groups (lactic acid, acetic acid, butyric acid etc.), thermophilic, proteolytic, saccharomycetic, coliforms, faecal coliforms, enteric pathogens and emerging microbes, Sources of microorganisms in food chain (raw materials, water, air, equipment etc) and microbiological quality of foods, Microbial growth characteristics: Reproduction and growth (fission, generation time optimum growth, growth curve etc). Microbial growth in foods: intrinsic (pH, Moisture content, oxidation-reduction potential, nutrient content, antimicrobial constituents and extrinsic parameters (temperature of storage, relative humidity of environment, presence and concentration of gases in the environment, Thermal destruction of microorganisms: Thermal death time, D Value, Z- Value, F-Value, thermal death time curve, 12 D Concept, Microbial food spoilage and food borne diseases, food pathogens, <i>bacillus cereus</i> and other <i>bacillus</i> species, <i>campylobacter</i>, <i>clostridium</i> species, <i>Enterobacteriaceae</i>, <i>E. coli</i>, <i>listeria monocytogens</i>, <i>salmonella</i>, <i>shigella</i>, <i>staphylococcus aureus</i>, <i>vibrio</i> species, <i>yersinia enterocolitica</i>, fungi, virus etc., Methods for the Microbiological examination of foods: Sampling activity and sampling plan, pure culture isolation: streaking, serial dilution and plating, cultivation maintenance and preservation/stocking of pure culture, Observation of Indicator organisms: Direct examination, enumeration methods, plate count, MPN, biochemical test, Rapid methods detection of specific organisms.	10	CO4	K2,K3,K4
V	HACCP and Food safety management systems: ISO 22000: Importance of implementing a HACCP system and how it can be applied to various products. Prerequisite programs, HACCP principles, some limitation of HACCP food safety objective (FSO). Food safety audits: Management review, audit certification and importance. Good manufacturing practices (GMP), Good hygienic practices (GHP), Food safety plan, food safety management risk analysis. Traceability food products recall and sanitation.	15	CO5	K2,K3 & K6

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

FOOD TECHNOLOGY		Course Code : P2R3BTSEC1:2
S.No	Course Outcome	Knowledge Level
Upon completion of course, the students will be able to		
CO-1	Elucidate the basic requirements of establish laboratory for testing samples as per the regulatory body's requirements	K2,K3,K4
CO-2	Describe the Scientific, technical knowledge about various food preservation techniques	K2 & K3
CO-3	Describe the basic concepts of packing of food materials, various parameters observed during packaging	K2,K3 & K4
CO-4	Describe the testing of food materials and identifying of microbial food contaminant	K2,K3,K4
CO-5	Explain the basic of food safety management system, good manufacturing practice and good hygienic practices	K2,K3 & K6

Relationship Matrix for CO, PO, PSO

Course	Programme Outcome (PO)					Programme Specific Outcome (PSO)					
Outcome (CO)	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

M. Sc Biotechnology

Core Course - 7 BIOPROCESS TECHNOLOGY

SEMESTER – III	
Title of The Course: BIOPROCESS TECHNOLOGY	Category of The Course: SKILL ENHANCEMENT COURSE
Course Code: P3R3BT CC7	Nature of The Skill : Employability
Marks : CIA : 25 + Ext: 75 = 100	Hrs / Week : 6
Credits : 5	Total Inst. Hrs : 90

COURSE OBJECTIVES:

- To Impart Knowledge On Bioreactors To Mass Multiply Microorganisms At Industrial Scale.
- To Introduce The Concept Of Growth Kinetics And Production Kinetics With Biologists Perspective.
- To Enlighten On Downstream Processing To Convert Them As Value Added Products.
- To Obtain Overall Holistic Knowledge On Fermentation Technology To Produce Various Biological Of Economic Value.
- To Create Awareness Among The Students About Food Quality Analysis.

SYLLABUS Core Paper-7 BIOPROCESS TECHNOLOGY				
Unit	Content	Hours	COs	Cognitive level
I	Introduction to fermentation. General requirements of fermentation. Microbial growth kinetics of batch and continuous culture. Solid substrate, slurry fermentation and its application. Microbial cell culture. Immobilization of cells and enzymes . Food Safety: Introduction to food safety aspects and food related hazards – HACCP and ISO .	10	CO1	K1 & K2

II	Types of bioreactors: Submerged reactors, surface reactors, mechanically agitated reactors, non-mechanically agitated reactors. Design of fermenters , body construction. Production of citric acid, penicillin and insulin. Isolation and improvement of Industrially important Micro-organisms, Media for Industrial fermentation and Sterilization.	10	CO2	K2,K3 & K5
III	Introduction to bioproducts and bioseparation. Primary recovery process: Cell disruption methods. Cell lysis and Flocculation : Osmotic and mechanical methods of lysis. Flocculation by electrolysis; polymorphic flocculation. Precipitation methods. Filtration: Principles, Conventional, Crossflow filtration. Sedimentation: Principles, Sedimentation coefficients. Extraction Principles, Liquid liquid extraction, aqueous two phase extraction, supercritical fluid extraction .	10	CO3	K2 & K5
IV	Down Stream Processing: Chromatography Techniques, Membrane separation, ultrafiltration. Drying .Principles and operation of vacuum dryer, shelf dryer, rotary dryer, freezer and spray dryer. Crystallization and Whole broth processing .	10	CO4	K4 & K5
V	Aerobic and anaerobic fermentation processes and their application in the field of biotechnology industry. Production of commercially important primary and secondary metabolites , Effluent Treatment and Fermentation Economics.	10	CO5	K3,K4 & K6

Reference Books:

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

Useful Websites:

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

Course outcomes:

BIOPROCESS TECHNOLOGY		Course Code : P3R3BTCC7
S.No	Course Outcome	Knowledge Level
Upon completion of course, the students will be able to		
CO-1	Outline the basis of Bioprocess Engineering	K2,K3,K4
CO-2	Relate reactors in fermentation	K2 & K3
CO-3	Differentiate fermentation processes	K2,K3 & K4
CO-4	Assess Scale up and Scale down	K2,K3,K5
CO-5	Compile the output of fermentation processes	K2,K3 & K6

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	2.9
CO-2	2	2	2	1	2	2	3	3	2	3	2.8
CO-3	2	3	2	2	2	2	2	2	3	2	3
CO-4	2	2	3	3	2	2	2	2	2	2	2.9
CO-5	2	2	2	2	3	2	2	3	3	2	3
Mean Overall Score											2.90
Result											High

M. Sc Biotechnology
Core Course - 8 IMMUNOLOGY

SEMESTER – III	
Title of The Course: IMMUNOLOGY	Category of The Course: SKILL ENHANCEMENT COURSE
Course Code: P3R3BT CC8	Nature of The Skill : Skill based
Marks : CIA : 25 + Ext: 75 = 100	Hrs / Week : 5
Credits : 5	Total Inst. Hrs : 75

COURSE OBJECTIVES

- Learn about structural features of components of immune system as well as their function.
- Learn about the transplantation and immunotherapy
- Emphasis on development of immune system and mechanisms by which our body elicit the immune response.
- Understand the imperative to think like an immunologist and predict about nature of immune response that develops against bacterial, viral or parasitic infection, and prove it by designing new experiments.
- Acquire about the Immunotechniques.

SYLLABUS Core Paper-08 IMMUNOLOGY				
Unit	Content	Hours	COs	Cognitive level
I	History and overview of the immune system. Types of immunity - innate, acquired, passive and active, self vs non-self-discrimination. Physiology of immune response: HI and CMI specificity and memory . Cells and organs of the immune system .Lymphoid tissue, origin and development. Hematopoiesis and differentiation of lymphocytes	10	CO1	K1 & K2
II	Lymphocyte-sub-populations of mouse and man. APC cells, lymphokines, Phagocytic cells, macrophage, dendritic cells, K and NK Cells. Nature and biology of antigens, epitopes, haptens, adjuvants . Immunoglobulins- structure, distribution and function. Immunoglobulin super family Isotypic, Allotypic and Idiotypic variants, generation of antibody diversity	10	CO2	K2,K3 & K5

III	Monoclonal antibody production and its applications. Types of vaccine and vaccination schedule. Role of MHC antigens in immune responses, Structure and function of class I and class II MHC molecules . MHC antigens in transplantation and HLA tissue typing . Transplantation immunology- immunological basis of graft rejection, clinical transplantation and Immunosuppressive therapy. Tumour Immunology - Tumour antigen, Immune response to tumours	10	CO3	K2 & K5
IV	Effector mechanisms in immunity - macrophage activation, cell mediated cytotoxicity , cytotoxicity assay. Hypersensitivity reactions and types. The complement system, mode of activation, classical and alternate pathway, biological functions of C proteins	10	CO4	K4 & K5
V	Immunotechniques- Principle and Applications: Immuno diffusion, Immuno fluorescence, Insitu localization technique - FISH and GISH . RIA and ELISA, FACS, Western blot, ELISPOT assay. Agglutination tests. VDRL test. Purification of antibodies, Quantitation of immunoglobulin by RID, EID and nephelometry, CMI techniques and Immunotherapy.	10	CO5	K3, K4 & K6

Reference Books:

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

Useful Websites:

- www.library.csusm.edu/course_guides/biology
- www.immunologylink.com
- <http://www.wiley.com/college/bio/karp12791/weblinks.html>

Course outcomes:

IMMUNOLOGY		Course Code : P3R3BTCC8
S.No	Course Outcome	Knowledge Level
Upon completion of course, the students will be able to		
CO-1	Illustrate various mechanisms that regulate immune responses and maintain tolerance	K2,K3,K4
CO-2	Describe key events and cellular players in antigen presentation, and how the nature of the antigen will shape resulting effectors responses	K2 & K3
CO-3	learn the concepts of cellular and molecular processes that represents the human immune system.	K2,K3 & K4
CO-4	elucidate the role of immunological regulation and tolerance at a cellular and molecular level	K2,K3,K5
CO-5	compile concepts on immunological principles and diagnosis	K2,K3 & K6

Relationship Matrix for CO, PO, PSO

Course	Programme Outcome (PO)					Programme Specific Outcome (PSO)					
Outcome (CO)	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	2.8
CO-2	2	2	2	1	2	2	3	3	2	3	2.85
CO-3	2	3	2	2	2	2	2	2	3	2	2.86
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											2.83
Result											High

Core Course - 9 BIOINFORMATICS

SEMESTER – III	
Title of The Course: BIOINFORMATICS	Category of The Course: SKILL ENHANCEMENT COURSE
Course Code: P3R3BT CC9	Nature of The Skill : Skill based
Marks : CIA : 25+75=100	Hrs / Week : 5
Credits : 5	Total Inst. Hrs : 75

COURSE OBJECTIVES:

- To knowledge of the basics of bioinformatics tools.
- To understand the core concepts of *Insilco* biological research.
- To understand the network behavior of the biological system and in particular their dynamic aspects, this requires the utilization of mathematical modeling tightly linked to the experiment.
- To understand some of the larger questions and issues with systems biology and large-scale data collection and analysis.
- To provide knowledge on knowledge of sources of sequences and protein structure data, an understanding of the relevance and importance of this data

SYLLABUS Core Paper-9 BIOINFORMATICS				
Unit	Content	Hours	COs	Cognitive level
I	Database concepts, Introduction to internet and its application, Introduction to bioinformatics, Protein and nucleotide databases, Information retrieval from biological databases, Sequence alignment and database searching-similarity searches using BLAST and FASTA . Artificial Intelligence: Introduction to biological neural network, motivation for artificial neural network (ANN), Big data analysis - DNA/RNA/protein sequence or structure data, gene expression data, protein-protein interaction (PPI) data, pathway data and gene ontology (GO) data	10	CO1	K1 & K2

II	Sequence alignment basics, match, mismatch, similarity, scoring an alignment, gap penalty, protein vs DNA alignments, Dot-matrix alignment , pairwise alignment. Global and local alignment algorithms, multiple sequence alignment-progressive alignment and Iterative alignment algorithms, consensus sequence, patterns and profiles, Database searching: Pairwise alignment based rigorous algorithm (Smith and Waterman) and Heuristic algorithms (FASTA and Blast). Multiple sequence alignment based database searching. PSI- Blast, PAM and Blosum matrices	10	CO2	K2,K3 & K5
III	Bioinformatics for genome sequencing, EST Clustering and analyses, Finding genes in prokaryotic and eukaryotic genomes, Regulatory sequence analysis , Bioinformatics for Genome maps and markers, Bioinformatics for understanding Genome variation , Protein structure-X-ray crystallography, The protein databank and the PDBSum- SCOP, CATH, DALI and HSSP ;Visualization of molecular structures-RasMol and Pymol; Protein secondary structure prediction, Fold Recognition; Transmembrane topology prediction	10	CO3	K2 & K5
IV	Molecular visualization tools. Rasmol, Chime and Spdb viewer. Structure analysis tools. VAST and DALI , Structural biology - Homology modeling, Bioinformatics for micro array designing and transcriptional profiling, Bioinformatics for metabolic reconstruction, Bioinformatics for phylogenetic analysis	10	CO4	K4 & K5
V	Medical application of Bioinformatics. Disease genes, Drug Discovery. History. Steps in drug discovery. Target Identification. Target Validation. QSAR . Lead Identification. Preclinical pharmacology and toxicology. ADME. Drug designing. Rational drug design . Computer aided drug design. Ligand based approach. Target based approach	10	CO5	K3,K4 & K6

Reference Books:

- Dassanayake S. Ranil, Y.I.N. Silva Gunawardene, 2011. Genomic and Proteomic Techniques, Narosa Publishing House Pvt. Ltd, New Delhi.
- Thiagarajan B, Rajalakshmi.P.A., 2009. Computational Biology, MJP publishers, Chennai.
- Bosu Orpita, Simminder Kaur Thukral, 2007. Bioinformatics Databases, Tools and Algorithms, Oxford University press, New Delhi.
- Rastogi.S.C, Mendiratta.N, Rastogi.P, 2004. Bioinformatics methods and applications, Prentice-Hall of India private limited, New Delhi.
- Lohar s. Prakash, 2009. Bioinformatics, MJP Publishers, Chennai.
- Stephen misener and Stephen A. Krawetz., 2000. Bioinformatics methods and protocols, Humana press Inc, New Jersey.

Course outcomes:

BIOINFORMATICS		Course Code : P3R3BTCC9
S. No	Course Outcome	Knowledge Level
Upon completion of course, the students will be able to		
CO-1	To get introduced to the basic concepts of Bioinformatics and its significance in Biological data analysis.	K2,K3,K4
CO-2	Describe the history, scope and importance of Bioinformatics and role of internet in Bioinformatics.	K2 & K3
CO-3	Explain about the methods to characterize and manage the different types of Biological data.	K2,K3 & K4
CO-4	Classify different types of Biological Databases.	K2,K3,K5
CO-5	Introduction to the basics of sequence alignment and analysis	K2,K3 & K6

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

PRACTICAL-III
(Covering CC7, CC8 & CC9)

SEMESTER – III	
Title of The Course: PRACTICAL - II (Bioprocess Technology, Immunology, Bioinformatics)	Category of The Course: CORE COURSE
Course Code: P3R3BTCC10P	Nature of The Skill : Employability
Marks : CIA : 40 + Ext: 60 = 100	Hrs / Week : 6
Credits : 5	Total Inst. Hrs : 90

COURSE OBJECTIVES

- To provide students with knowledge of wide ranging topics related to stem cells, regenerative medicine and tissue engineering.
- To offer the student state of the art education of stems cells and how the Pluripotent and Multipotent cells can be used to treat the disorders.
- To acquire knowledge about stem cell cycle.
- To review the current scenario of cell culture applications in bioartificial organs development and transplantation.

SYLLABUS | Core Paper-12 | PRACTICAL-III (covering CC7,CC8 & CC9)

Unit	Content	Hours	COs	Cognitive level
A	(A) Bioinformatics-practical 1. Sequence retrieval from Genbank 2. Sequence retrieval from Uniprot. 3. Sequence identity search- Sequence similarity search using BLAST 4. Sequence similarity search using FASTA 5. Sequence similarity search using PSI BLAST 6. Sequence similarity search using PHI- BLAST. 7. Prediction of signal sequence using SignalP online tool 8. Pattern Search (Domains & Motifs) using Pfam 9. ORF gene Search - Genscan 10. Sequence translation using ExPASy translate tool 11. Characterization of retrieved protein sequence by ProtParam tool. 12. Pair-wise global sequence alignment using EBI-EMBOSS Needleman Wunsch tool 13. Pair-wise local sequence alignment using EBI-EMBOSS Smith Waterman tool 14. Multiple sequence alignment using EBI-CLUSTALW2. 15. PHYLOGENY- Phylogenetic tree using PHYLIP. 16. Prediction of secondary protein structure using GOR (Garnier Osguthorpe-Robson) server. 17. Prediction of tertiary protein structure using SWISS-MODEL Server 18. Validation of the predicted structure using PROCHECK server 19. Molecular visualization of proteins using RASMOL. 20. Docking of small molecule with protein structure using Hex software. 21. Docking of two proteins using PatchDock (Protein-Protein docking) tool. 22. Retrieval of E.Coli glycolytic pathway from KEGG	15	CO1 CO2 CO3 CO4 CO5	K1,K2,K3,K4 &K5

B	(B) Immunology - practical 1. Identification of various immune cells from human peripheral blood. 2. Lymphocyte separation and identification 3. Determination of lymphocyte viability by trypan blue method 4. WBC counting 5. Preparation of serum and plasma 6. Electrophoretic profile of human serum in native PAGE 7. Preparation of cellular antigen – human RBC 8. Preparation of antigen-adjuvant mixture for production of polyclonal antibody 9. Isolation of IgG molecule from serum 10. Immunodiagnosics: CRP 11. Immunodiagnosics: ASO 12. Immunodiagnosics: Widal 13. Immunodiagnosics: RA 14. Immunodiagnosics: Blood grouping and typing 15. Immunodiagnosics: hCG 16. ELISA 17. Radial Immunodiffusion 18. Ouchterlony Immunodiffusion 19. Immunoelectrophoresis 20. Rocket electrophoresis 21. Counter current immunoelectrophoresis. 22. Bioassays for cytokines 23. Radioimmunoassays (Demonstration)	15	CO1 CO2 CO3 CO4 CO5	K2,K3,K4
C	(C) Bioprocess Technology - Practical 1. Parts and design of fermenter 2. Solid state fermentation 3. Submerged fermentation 4. Foaming and antifoaming agents 5. Media preparation and sterilization 6. Isolation of industrially important microorganisms for microbial processes. 7. Conservation of Bacteria by Lyophilization. 8. Production and estimation of protease 9. Production and estimation of amylase. 10. Production of wine using grapes 11. Production of penicillin 12. Determination of penicillin activity 13. Citric acid production 14. Use of alginate for cell immobilization. 15. Media standardization (C:N ratio) for maximum biomass production of an industrially important microorganism. 16. Cell disruption (Sonication) 17. Aqueous Two Phase Extraction of enzymes	15	CO1 CO2 CO3 CO4 CO5	K2,K3,K4 & K5

Course outcomes:

Practical III (Covering CC7,CC8)		Course Code : P3R3BTCC10P
S.No	Course Outcome	Knowledge Level
Upon completion of course, the students will be able to		
CO-1	To understand the bioinformatics software	K2,K3,K4
CO-2	To Explore The Diagnosis, Pathogenesis of Disease	K2 & K3
CO-3	To Isolate, Identify & Enumerate Immune Cells	K2,K3 & K4
CO-4	To Learn The Technique Of Immunodiagnostics	K2,K3,K5
CO-5	To Study Upstream & Downstream Techniques	K2,K3 & K6

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	2.8
CO-2	2	2	2	1	2	2	3	3	2	3	2.85
CO-3	2	3	2	2	2	2	2	2	3	2	2.86
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											2.83
Result											High

Discipline Specific Elective course
RESEARCH METHODOLOGY

SEMESTER – III	
Title of The Course: RESEARCH METHODOLOGY	Category of The Course: SKILL ENHANCEMENT COURSE
Course Code: P3R3BT DSE5:1	Nature of The Skill : Skill based
Marks : CIA : 25 + Ext: 75 = 100	Hrs / Week : 4
Credits : 3	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.

SYLLABUS Discipline Specific Elective – 5:1 RESEARCH METHODOLOGY				
Unit	Content	Hours	COs	Cognitive level
I	Research Methodology - An Introduction: Meaning of Research, Objectives of Research, Types of Research, Research Approaches, Importance of knowing how research is done, Research Process, Criteria of good research. Defining the Research Problem; Research Design; Sampling Design ; Methods of Data Collection; Processing and Analysis of Data; Sampling Fundamentals	10	CO1	K1
II	Review of literature, Writing the Research Report (Thesis and publications): Components of research report - Title, Authors, Addresses, Abstract, Keywords, Introduction, Materials and Methods, Results, Discussion, Summary, Acknowledgements and Bibliography	10	CO2	K2 &K6

III	Standard Deviation- T test. Analysis of Variance components (ANOVA) for fixed effect model; Total, treatment and error of squares, Degrees of freedom, Confidence interval; ANOVA for random effects model, Estimation of variance components, Model adequacy checking. Two factor Factorial Design, Basic definitions and principles, main effect and interaction, response surface and contour plots, General arrangement for a two factor factorial design	10	CO3	K3
IV	Spreadsheet Tool: Introduction to spreadsheet application, features and functions, Using formulas and functions, Data storing, Features for Statistical data analysis, Generating charts/ graph and other features. Presentation Tool: Introduction to presentation tool, features and functions, Creating presentation, Customizing presentation, Showing presentation. Tools used may be Microsoft Power Point, Open Office or similar tool	10	CO4	K1 & K4
V	Web Search: Introduction to Internet, Use of Internet and WWW, Using search engine like Google, Yahoo, Pubmed, Science direct, Scopus etc, and Using advanced search techniques	10	CO5	K1 & K2

Reference Books:

- Montgomery, Douglas C. (2007), 5/e, Design and Analysis of Experiments, (Wiley India).
- Montgomery, Douglas C. & Runger, George C. (2007), 3/e, Applied Statistics & Probability for Engineers (Wiley India).
- Kothari C.K. (2004), 2/e, Research Methodology- Methods and Techniques (New Age International, New Delhi).
- Krishnaswamy, K.N., Sivakumar, Appa Iyer and Mathiranjani M. (2006), Management Research Methodology; Integration of Principles, Methods and Techniques (Pearson Education, New Delhi).

Useful Websites

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

Course outcomes:

RESEARCH METHODOLOGY			Course Code : P3R3BTDSE5:1		
S.No	Course Outcome			Knowledge Level	
Upon completion of course, the students will be able to					
CO-1	Understand the bases for research			K2,K3,K4	
CO-2	To know about research proposal and dissertation writing.			K2 & K3	
CO-3	To know about Statistical application in research			K2,K3 & K4	
CO-4	To know about office tools used in research			K2,K3,K5	
CO-5	To know about search engines.			K2,K3 & K6	

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	2.8
CO-2	2	2	2	1	2	2	3	3	2	3	2.85
CO-3	2	3	2	2	2	2	2	2	3	2	2.86
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											2.83
Result											High

Discipline Specific Elective**ONCOLOGY**

SEMESTER – III	
Title of The Course: ONCOLOGY	Category of The Course: Discipline Specific Elective
Course Code: P3R3BTDSE5:2	Nature of The Skill : knowledgeable
Marks : CIA : 25 + Ext: 75 = 100	Hrs / Week : 4
Credits : 3	Total Inst. Hrs : 60

COURSE OBJECTIVES

- Learn about the basics of cellular oncogenesis.
- Obtain a strong foundation about the symptoms and treatment for Cancer.
- Explain the properties of Oncogenes and its expressions.
- Acquire knowledge about the tumour expression and suppression
- Develop the knowledge regarding the current technology for cancer approach.

SYLLABUS Discipline Specific Elective – 5:2 ONCOLOGY				
Unit	Content	Hours	COs	Cognitive level
I	Eukaryotic cell- Structure, functions and properties- Cell cycle and regulations- Apoptosis - Genetic regulations of Apoptosis. Oncogenesis .	10	CO1	K1
II	Types of Cancer and causative factors, Symptoms- Prognosis and diagnosis of Cancer, Methods of treatment for Cancer- Chemotherapy , Radiation therapy and Gene therapy .	10	CO2	K2 & K6
III	Tumour expressor and suppressor genes. Expression of Oncogenes, Gene isolation- Primer Designing, PCR Amplification , Cloning and Sequencing, Molecular Markers .	10	CO3	K3
IV	Stem cells- Role of Stem cells in tumour expression and Suppression, HOX genes - Regulatory mechanism	10	CO4	K1 & K4
V	Emerging technologies for Cancer Approach- Targeted delivery & Synthetic lethal approaches, Microarray , Nano technology.	10	CO5	K1 & K2

Reference Books:

- Robert A Weinberg (2023) The biology of Cancer ,3rd Edition, WW Norton & Co
- Gary, Kimberly (2019) Cancer: Prevention,Early detection, Treatment and Recovery, John Wiley & sons
- Carsten Carlberg,Velleur (2018) Cancer Biology : How Science works, Springer Publishers.
- Kleinsmith, (2016), Principles of Cancer Biology, 1st Edition, Pearson.
- Lauren Pecorino (2021), Molecular Biology of Cancer, 5th Edition, Oxford University Press.

Useful Websites

- <https://digital.wwnorton.com/cancer2>
- [https://bio.libretexts.org/Bookshelves/Introductory_and_General_Biology/Biology_\(Kimball\)](https://bio.libretexts.org/Bookshelves/Introductory_and_General_Biology/Biology_(Kimball))

CANCER BIOLOGY	Course Code :
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S. No.	Course Outcome	Knowledge Level
Upon completion of the course, the students will be able to		
CO - 1	obtain acquaintance on Molecular aspects of cancer	K3
CO - 2	Grasp the various treatment for cancer	K2
CO - 3	comprehend the concept of Expression of genes.	K1
CO - 4	understand about Stem cells and their roles	K6
CO - 5	demonstrate the new approach for cancer	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	2.8
CO-2	2	2	2	1	2	2	3	3	2	3	2.85
CO-3	2	3	2	2	2	2	2	2	3	2	2.86
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											2.83
Result											High

Skill Enhancement Course - NANO BIOTECHNOLOGY

SEMESTER-III	
Title of The Course: NANO BIOTECHNOLOGY	Category of The Course : Skill Enhancement Course
Course Code : P3R3BTSEC2:1	Nature of The Skill : Employability
Marks : CIA : 40 + Ext: 60 = 100	Hrs / Week : 4
Credits : 2	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.

SYLLABUS SKILL ENHANCEMENT COURSE-2:1 NANO BIOTECHNOLOGY				
Unit	Content	Hours	COs	Cognitive level
I	Introduction to Nanotechnology- Scientific revolution, Feynman's vision, Classification of nanobiomaterials -Types of nanomaterials – nanoparticles, nanotubes, nanowires, Nanofibers, Size dependent variation in the properties of Nanomaterials, Nature's Nanophenomena.	7	CO1	K1
II	Preparation of Nanomaterials, Top down and bottom up approaches, Biosynthesis, Nanobiomaterials- Polymer, Ceramic, Metal based Nanobiomaterials, Carbon based Nanomaterials, DNA based Nanostructures, Protein based Nanostructures, Quantum dots, Magnetic Nanoparticles, Nanofibres, Hydrogels, Films and Scaffolds.	7	CO2	K4

III	Application of Nanomaterials in Bone substitutes and Dentistry, Food and Cosmetic applications, Bio-sensors and Lab-on-a-chip , Bio-devices and implantable devices, Bioremediation, Nanomaterials for anti-microbial coating – medical implants and paints, Application of Nanotechnology in textile industry.	7	CO3	K1 & K5
IV	Nanomaterials for diagnosis and therapy, Implications of drug delivery, Nano-carriers for application in medicine, polymeric nanoparticles as drug carriers, Drug release mechanism, Targeted Drug Delivery using nanocarriers, Nanoparticle technologies for cancer therapy and diagnosis, Point of Care and Personalized medicine, Magnetic nanoparticles for imaging and Hyperthermia.	7	CO4	K2
V	Nanotoxicology, Portals of Entry of the nanoparticles into the Human Body, Bio-toxicity of Nanoparticles , Nanoparticles in Mammalian systems and Health threats, Biological response and cellular interaction of implant materials and scaffolds, Risk assessment and Safety Regulation of nanoparticles.	7	CO5	K5

Reference Books:

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

Useful Websites:

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

Course outcomes:

NANOTECHNOLOGY		Course Code : P3R3BTSC2:1
S.No	Course Outcome	Knowledge Level
Upon completion of course, the students will be able to		
CO-1	Understand the bases for Introduction to Nanotechnology	K2,K3,K4
CO-2	To impart understanding on Nanoparticle based Drug Delivery.	K2 & K3
CO-3	Fabrication of nanomaterials for bone tissue grafting	K2,K3 & K4
CO-4	Methods of Nanofabrication	K2,K3,K5
CO-5	Understand the application of Nanotechnology	K2,K3 & K6

Relationship Matrix for CO, PO, PSO

Course	Programme Outcome (PO)					Programme Specific Outcome (PSO)					
Outcome (CO)	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	2.8
CO-2	2	2	2	1	2	2	3	3	2	3	2.85
CO-3	2	3	2	2	2	2	2	2	3	2	2.86
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											2.83
Result											High

Skill Enhancement Course - BIOETHICS, BIOSAFETY, IPR & SYSTEM BIOLOGY

SEMESTER – III	
Title of The Course: BIOETHICS, BIOSAFETY, IPR & SYSTEM BIOLOGY	Category of The Course: SKILL ENHANCEMENT COURSE
Course Code: P3R3BTSE2:2	Nature of The Skill : Skill based
Marks : CIA : 25 + Ext: 75 = 100	Hrs / Week : 4
Credits : 2	Total Inst. Hrs : 60

COURSE OBJECTIVES

- To provide basic knowledge on intellectual property rights and their implications in biological research and product development
- To become familiar with India's IPR Policy
- To learn Biosafety and risk assessment of products derived from biotechnology and regulation of such products
- To become familiar with ethical issues in biological research. This course will focus on consequences of biomedical research technologies such as cloning of whole organisms, genetic modifications, DNA testing.

SYLLABUS SKILL ENHANCEMENT COURSE-2:2 BIOETHICS, BIOSAFETY, IPR & SYSTEM BIOLOGY				
Unit	Content	Hours	COs	Cognitive level
I	Introduction to Bioethics Need for bioethics in social and cultural issues. Bioethics & GMO's Issues and concerns pertaining to Genetically modified foods & food crops, Organisms and their possible health implications and mixing up with the gene-pool. Bioethics in Medicine Protocols of ethical concerns related to prenatal diagnosis, gene therapy, Organ transplantation, Xenotransplantation , Containment facilities for genetic engineering experiments, regulations on field experiments and release of GMO's labeling of GM foods.	10	CO1	K2,K3 & K4

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

V	Geographical Indications - Indication of Source and Geographical Indication. Procedure for Registration, Duration of Protection and Renewal. Infringement, Penalties and Remedies. Layout- Designs of Integrated Circuits: Conditions and Procedure for Registration. Duration and Effect of Registration Protection of Plant variety and Plant breeders' rights in India. Protection of traditional knowledge, Bioprospecting and biopiracy. India's new IP Policy (2016), Govt of India's steps to promote IPR. Career opportunities in IP. Entrepreneurship : Definition and importance, Characteristics and functions of an entrepreneur.	10	CO5	K4,K5 & K6
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Reference Books:

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

Course outcomes:

BIOETHICS,BIOSAFETY,IPR & SYSTEM BIOLOGY		Course Code : P3R3BTSEC2:2
S.No	Course Outcome	Knowledge Level
Upon completion of course, the students will be able to		
CO-1	Understand the basics of Biosafety and bioethics and its impact on biological sciences and the importance of human life.	K2,K3,K4
CO-2	Apply the knowledge to recognize the importance of Biosafety guidelines and good clinical practices.	K2 & K3
CO-3	Acquire adequate knowledge in the use of genetically modified organisms and its effect on human health.	K2,K3 & K4
CO-4	Evaluate the benefits of GM technology and importance of IPR	K2,K3,K5
CO-5	Analyse the importance of protection of new knowledge and innovations and its role in business and entrepreneurship	K2,K3 & K6

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	2.8
CO-2	2	2	2	1	2	2	3	3	2	3	2.85
CO-3	2	3	2	2	2	2	2	2	3	2	2.86
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											2.83
Result											High

INTERNSHIP

SEMESTER – III	
Title of The Course: INTERNSHIP	Category of The Course: SKILL ENHANCEMENT COURSE
Course Code: P3R3BTINT	Nature of The Skill : Skill based
Marks : CIA : 100	Hrs / Week :
Credits : 3	Total Inst. Hrs :

Core Course-STEM CELL BIOLOGY

SEMESTER – III	
Title of The Course: STEM CELL TECHNOLOGY	Category of The Course: Skill Enhancement Course
Course Code: P4R3BT CC11	Nature of The Skill : Skill based
Marks : CIA : 25 + Ext: 75 = 100	Hrs / Week : 6
Credits : 5	Total Inst. Hrs : 75

COURSE OBJECTIVES

- To provide students with knowledge of wide ranging topics related to stem cells, regenerative medicine and tissue engineering.
- To offer the student state of the art education of stems cells and how the Pluripotent and Multipotent cells can be used to treat the disorders.
- To acquire knowledge about stem cell cycle.
- To review the current scenario of cell culture applications in bioartificial organs development and transplantation.

SYLLABUS Core Paper 11 STEM CELL BIOLOGY				
Unit	Content	Hours	COs	Cognitive level
I	Stem cells - Definition, Characterization, Pluripotency, Self-renewal and differentiation. Types of stem cells- Embryonic stem cells , Adult stem cells and mesenchymal stem Cells, Adipose stem cells	7	CO1	K1

II	Stem cell niche, Niche specification - Drosophila germ line stem cells. Receptors, genes and markers of stem cells	7	CO2	K1 & K2
III	Stem cell isolation and culture techniques. Characterization of stem cells	7	CO3	K3, K4
IV	Stem cell cycle. Chromatin modification and transcriptional regulation, chromatin modifying factors, Chromosomal inactivation. JAK -STAT pathway , Ras\Raf pathway, PI3K cell signaling , p53 check points, Role of LIF pathway in cell cycle control	7	CO4	K3,K3 & K5
V	Applications of Embryonic stem cells, Bone marrow stem cells, Adipose derived stem cells and Hematopoietic stem cells. Ethics in human stem cell research	7	CO5	K3,K4 & K5

Reference Books:

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

Course outcomes:

Stem Cell Technology		Course Code : P4R3BTCC11
S.No	Course Outcome	Knowledge Level
Upon completion of course, the students will be able to		
CO-1	To understand the major discoveries of stem cell biology	K2,K3,K4
CO-2	To provide basic knowledge about stem cell niche and functions	K2 & K3
CO-3	To enlighten the students on Stem cell isolation and culture techniques	K2,K3 & K4
CO-4	To update the knowledge on Stem cell cycle	K2,K3,K5
CO-5	To assess and appraise Applications of Embryonic stem cells.	K2,K3 & K6

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	2.8
CO-2	2	2	2	1	2	2	3	3	2	3	2.85
CO-3	2	3	2	2	2	2	2	2	3	2	2.86
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											2.83
Result											High

M. Sc Biotechnology

Core course- GENOMICS AND PROTEOMICS

SEMESTER – III	
Title of The Course: GENOMICS & PROTEOMICS	Category of The Course: Skill Enhancement Course
Course Code: P4R3BT CC12	Nature of The Skill : knowledgeable
Marks : CIA : 25 + Ext: 75 = 100	Hrs / Week : 6
Credits : 5	Total Inst. Hrs : 75

COURSE OBJECTIVES

- To understand the genome architecture and to extract information of gene function, gene regulation, protein evolution and targets for drug designing.
- To provide students with the skills from acquisition of genomic data to its analysis.
- To provide the knowledge of Next Generation Sequencing (NGS) through various tools.
- To provide a brief introduction about human genome project and other genome projects, a precise note on the transcript analysis techniques such as DNA chip and microarray for gene screening,
- Students to gain the knowledge on advanced techniques for example co-immunoprecipitation, protein microarray and computational tools of protein - protein interactions.

SYLLABUS Core Paper 11 Genomics and Proteomics				
Unit	Content	Hours	COs	Cognitive level
I	Genome Organization Anatomy of the Eukaryotic and Prokaryotic Genome, Repetitive DNA Content of Genomes. How genes work, Gene-protein relations, Genetic fine structure, Mutational sites Complementation, Genome Mapping – Mapping Genomes, Genetic and Physical Maps, Sequencing Genomes , Methodology for DNA Sequencing, Assembly of a Contiguous DNA Sequence, understanding a Genome Sequence, Locating the Genes in a Genome Sequence, Determining the Functions of Individual Genes.	Hours : 15 7	CO1	K1

II	Genome Analysis Hours: 15 DNA Sequencing databases, Sequence analysis programs, Pairwise sequence alignment, Multiple sequence alignment, The first complete genome sequence and database, DNA sequencing, Genomic sequencing, Sequencing cDNA Libraries of expressed genes, Accuracy and computers storage of sequence, Sequence formats, Conversions of one sequence format to others.	7	CO2	K1 & K2
III	Gene Prediction and Genome Rearrangement Hours: 14 Introduction, testing the reliability of an ORF Prediction , gene prediction methods and tools, The Biological Problem, Permutations .Analyzing Genomes with Reversals of Oriented Conserved Segments, Applications to Complex Genomes, Comparative Genomics – Completed genomes, Sequence assembly and gene identification, functional classification of genes.	7	CO3	K3, K4
IV	Protein Classification Hours: 13 Structural elements and terminology: Helix, Sheet, Strand, Loop and coil, Active site, Architecture, Blocks, Class and Domains, Fold, Motif, PSSM . Principles of classification: Based on structural features, Phylogenetic relationship. Properties of protein in solution and in membranes. Interaction with other molecules like lipids, carbohydrates, metal Ions.	7	CO4	K3,K3 & K5
V	Protein Structure Prediction Hours: 12 Use of sequence pattern, leucine zipper , coiled coil, transmembrane, signal peptide, cleavage site. Secondary structure prediction: Chou – Fasman / GOR method , Neural network , nearest neighbor method, tertiary structure prediction, threading profile, contact potential, modeling.	7	CO5	K3,K4 & K5

Reference Books: 1. Discovering Genomics, Proteomics and Bioinformatics. Campbell, A.M. & Heyer, L.J., 2002. Discovering Genomics, Proteomics and Bioinformatics. Benjamin. 2. An Introduction to Molecular Human Genetics. Pasternak, 2000. Fitzgerald 3. Genome. Brown, T.A. 2002. John Wiley Press, US. 4. Principles of Genome Analysis & Genomics. Primrose and Twyman, 2003. Blackwell. 5. From Genes to Genomes. Dale and Schartz, 2003. Humana. 6. Principles of Biochemistry. Lehninger, A. L., 1984. CBS publishers and distributors, New Delhi, India 7. Principles of Biochemistry. Horton, Moran, Ochs, Rawn, Scrimgeour., 2005. Prentice Hall Publishers.

Course outcomes:

Stem Cell Technology		Course Code : P4R3BTCC12
S.No	Course Outcome	Knowledge Level
Upon completion of course, the students will be able to		
CO-1	Explain genomic technologies and the ways in which genomic data are stored.	K2,K3,K4
CO-2	Have hands-on experience on various bioinformatics tools available for analyzing genes and genomes.	K2 & K3
CO-3	Describe the different secondary structure of protein. Interpret the properties of protein in solution and in membranes.	K2,K3 & K4
CO-4	The students will also study the depth of expression analysis of a protein.	K2,K3,K5
CO-5	The student will be equipped with knowledge of various proteomic techniques required to measure the expression level of proteins which could be used in future	K2,K3 & K6

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	2.8
CO-2	2	2	2	1	2	2	3	3	2	3	2.85
CO-3	2	3	2	2	2	2	2	2	3	2	2.86
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											2.83
Result											High

M. Sc Biotechnology

Core Course - 13 PROJECT WORK

SEMESTER – IV	
Title of The Course: PROJECT WORK	Category of The Course: SKILL ENHANCEMENT COURSE
Course Code: P4R3BT CC13PW	Nature of The Skill : Skill based
Marks : CIA : 100	Hrs / Week : 18
Credits : 10	Total Inst. Hrs : 270