M.Sc. BIOTECHNOLOGY

SEM	Course Code	Course	Course Title	Ins. Hrs / Week	Credit	Exam Hrs	Marks		Total
							CIA	ESE	
I	20PBT1CC1	Core – I	Bioinstrumentation	6	5	3	25	75	100
	20PBT1CC2	Core – II	Advanced Biochemistry	6	5	3	25	75	100
	20PBT1CC3	Core – III	Immunology and Immunotechnology	6	4	3	25	75	100
	20PBT1CC4P	Core – IV	Bioinstrumentation, Advanced Biochemistry, Immunology and Immunotechnology - Practical	6	4	4	25	75	100
	20PBT1DE1	DSE – I#		6	4	3	25	75	100
			TOTAL	**30**	**22**				**500**
II	20PBT2CC5	Core – V	Enzymology and Enzyme Technology	6	5	3	25	75	100
	20PBT2CC6	Core – VI	Molecular Biology and Genetic Engineering	6	5	3	25	75	100
	20PBT2CC7	Core – VII	Recombinant DNA Technology	6	4	3	25	75	100
	20PBT2CC8	Core – VIII	Enzymology and Enzyme Technology, Genetic Engineering and Molecular Techniques, Recombinant DNA Technology - Practical	6	4	4	25	75	100
	20PBT2DE2	DSE – II #		6	4	3	25	75	100
			TOTAL	**30**	**22**				**500**
III	20PBT3CC9	Core – IX	Plant Biotechnology	6	5	3	25	75	100
	20PBT3CC10	Core – X	Animal Biotechnology	6	5	3	25	75	100
	20PBT3CC11	Core– XI	Microbial Technology	6	4	3	25	75	100
	20PBT3CC12	Core – XII	Plant Biotechnology, Animal Biotechnology, Microbial Technology - Practical	6	4	4	25	75	100
	20PBT3DE3	DSE – III#		6	4	3	25	75	100
	20PBT3EC1	Extra Credit Course – I	Online Course (MOOC)	-	1*	-	-	-	-
			TOTAL	**30**	**22**				**500**
IV	20PBT4CC13	Core – XIII	Bioinformatics and Biostatistics	6	5	3	25	75	100
	20PBT4CC14	Core – XIV	Environmental Biotechnology	6	5	3	25	75	100
	20PBT4CC15	Core – XV	Bioinformatics andBiostatistics, Environmental Biotechnology - Practical	6	5	4	25	75	100
	20PBT4PW	Project	Project	12	8	-	-	200	200
	20PCNOC	Online Course (Compulsory)		-	1	-	-	-	-
	20PBT4EC2	Extra Credit Course – II	Biotechnology for career Examinations	-	5*	3	-	100	100*
			TOTAL	**30**	**24**				**500**
			GRAND TOTAL		**90**				**2000**

***Not considered for grand total and CGPA**

Discipline Specific Electives

SEMESTER	COURSE CODE	COURSE TITLE
I	20PBT1DE1A	Biodiversity and Bioprospecting
	20PBT1DE1B	Biofertilizer Technology
II	20PBT2DE2A	Genomics and Proteomics
	20PBT2DE2B	Biopharmaceuticals in Nanomedicine
III	20PBT3DE3A	Stem Cell Biology
	20PBT3DE3B	Marine Biotechnology

Semester	Code	Course	Title of the Course	Hours	Credits	Max. marks	Internal marks	External marks
I	20PBT1CC1	Core – I	BIOINSTRUMENTATION	6	5	100	25	75

Course Outcomes

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

1. Integrate spectroscopic techniques in their research projects and utilize them to discover the structure of novel compounds.
2. Gain knowledge on the principles, instrumentation and applications of centrifugation.
3. Understand the working principles, construction and applications of all separation techniques involved in purification.
4. Understand the various Medical instrumentation.
5. Gain knowledge on different scientific research designs and methods in field biology

UNIT I Microscopy and Spectroscopy: 18 hours

Microscope – Bright field, Dark field, Phase contrast, Microscopy - Fluorescent Microscope, Electron microscopy - Scanning Electron Microscope, Transmission Electron Microscope, Confocal Laser Scanning Microscope, Atomic Force Microscope. General design and components of spectroscopy, UV –Visible, IR- Raman spectroscopy, NMR spectroscopy, Auger electron and #Atomic absorption spectroscopy (AAS)#.

UNIT II Centrifugation and Analytical bioprocess: 18 hours

Principles of centrifugation, concepts of RCF. Different types of Centrifuges and their uses, differential and density gradient centrifugation, separation methods in Preparative and Analytical Ultra Centrifuges, applications of analytical ultracentrifuge, Analysis of biomass, Gas analysis for O_2 and CO_2, #Flow injection analysis#.

UNIT III Separation Techniques: **18 hours**

Chromatography – Principles of adsorption and partition chromatography, ion exchange, gel permeation chromatography, affinity chromatography, Gas liquid chromatography and HPLC; Mass spectrometry, Electrophoretic techniques – Principles of Electrophoresis, Continuous, zonal and capillary electrophoresis, Electrophoresis of Proteins-SDS-PAGE, IEF, 2D-PAGE, #Agarose Gel Electrophoresis of DNA#.

UNIT IV Radio labeling techniques and Medical Instrumentation: 18 hours

Detection and measurement of different types of radioisotopes normally used in biology, molecular imaging of radioactive material, safety guidelines; Medical instrumentation–Single neuron recording, patch-clamp recording, ECG, EEG, Brain activity recording, lesion and stimulation of brain,PET, MRI, fMRI, #computerized axial tomography scan#.

UNIT V Thermal analysis and methods in field Biology: 18 hours

Thermo gravimetric analysis, Differential thermal analysis, Differential scanning calorimetry (DSC);Methods of estimating population density of animals and plants, ranging patterns through direct, indirect and remote observations, #sampling methods in the study of behavior#, habitat characterization-ground and remote sensing methods.

##Self –study portion

Text Books:

T.B-1 Chatwal and Anand, Instrumental Methods of Chemical Analysis, 6th edition, Himalaya Publishing House, 2006.

T.B-2 Upadhyay, Upadhyay and Nath, Biophysical Chemistry (Principles & Technology), 9th edition, Himalaya Publishing House, 2009.

T.B-3 Willard, H.H., Merrit, J.A., Dean, L.L. and Setlle, F.A., Instrumental Methods of Analysis, 7thedition, CBS Publishers and Distributors, 2004

Unit I Chapter I, II, III, T.B-1
Unit II Chapter V, T.B-2
Unit III Chapter 7, T.B-2
Unit IV Chapter 3 T.B-3
Unit V Chapter 4 T.B-3

Books for Reference:

1. Wilson and Walker, Principles and techniques of Biochemistry and Molecular Biology,6thedition Cambridge University Press, 2005.
2. Skoog, D., Instrumental Methods of Analysis, 5th Edition, David Hariss Publishers, 2000.

Web Source

1. https://www.epictraining.ca/course/15958/mississauga/bioinstrumentation-distance
2. https://bioinstrumentation.mit.edu/
3. https://www.egr.msu.edu/classes/ece445/mason/Files/ECE445_1-Intro.pdf
4. https://nptel.ac.in/courses/102/108/102108082/

Relationship Matrix for Course Outcomes, Programme Outcomes and Programme Specific Outcomes:

Semester	**Code**			**Title of the Paper**			**Hours**			**Credits**
I	**20PBT1CC1**			**BIOINSTRUMENTATION**			**6**			**5**
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓	✓	✓	✓	✓		✓	✓	✓
CO2	✓	✓	✓	✓		✓	✓	✓	✓	✓
CO3	✓	✓	✓	✓		✓		✓	✓	✓
CO4	✓	✓	✓	✓		✓	✓	✓	✓	✓
CO5	✓	✓	✓	✓	✓	✓		✓	✓	✓
Number of Matches = 44, Relationship : High										

Prepared by: **Checked by:**

1. Dr.B.NazeemaBanu 1.K.Gobalan

Note:

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very poor	Poor	Moderate	High	Very high

Semester	Code	Course	Title of the Course	Hours	Credits	Max. marks	Internal marks	External marks
I	20PBT1CC2	Core – II	ADVANCED BIOCHEMISTRY	6	5	100	25	75

Course Outcomes

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

1. Acquire the knowledge about bioenergetics and its principles.
2. Describe the metabolic pathways of carbohydrate and its regulatory mechanisms.
3. Illustrate the structure, biological functions and metabolism of lipids.
4. Intellectual about the structures of amino acids, their chemical properties and their metabolism.
5. Assess the synthesis of purines and pyrimidines along with their regulation and explain and provide the inter-relationships of biomolecules and their consequences for interpreting & solving clinical problems.

Unit I Bioenergetics: 18 hours

Free energy and entropy. Phosphoryl group transfers andATP. Enzymes involved in redox reactions. The electron transport chain–organization and role in electron capture. Electron transfer reactions inmitochondria. Oxidative phosphorylation- F1/F0 ATPase- structure and mechanism of action.#Thechemiosmotic theory#. Inhibitors of respiratorychain and Oxidative phosphorylation – uncouplers, ionophores.Regulation of oxidative phosphorylation.Mitochondrial transport systems- ATP/ADP exchange, malate /glycerophosphate shuttle.

Unit II Carbohydrate metabolism: 18 hours

Classification, Structure and Isomerism.Monosaccharides, Oligosaccharides, Polysaccharides– Structure and Properties. Metabolism of Carbohydrates- Glycolysis, Mechanism of pyruvate Dehydrogenase,Citric acid cycle, HMP shunt, Glucuronic acid Gluconeogenesis, Glycogenesis, Glycogenolysis, Glyoxylate cycle. #Metabolic disorders associated with carbohydrate metabolism#.CSDB(Carbohydrate Structure Database,GlycomeDB,Calvin cycle.

Unit III Lipid metabolism: 18 hours

Biosynthesis of fatty acid and its regulation,biosynthesis of triacylglycerol, phospholipids and cholesterol. Metabolism of triacylglycerol during stress.α, β,γ, Oxidation of fatty acids– Role of carnitine cycle in the regulation of β -oxidation. #Ketogenesis and its control.Lipoprotein types and its functions#. Metabolic disorders associated with lipid metabolism,LMSD(Lipid Maps Structure Database),Lipid Bank.

UNIT IV Metabolism of amino acids, proteins: 18 hours

Overview of biosynthesis of nonessential amino acids.Catabolism of amino acid-transamination, deamination, ammonia formation, urea cycle and its significance.Catabolism of carbon skeletons of amino acids. Protein – classification, types, characteristics and structures,PDB(Protein DataBank), Ramachandran plot,PROCHECK Solid state synthesis of peptides, Sequence determination. #metabolic disorders associated with aminoacid metabolism#.

UNIT VMetabolism of purines and pyrimidines: 18 hours

Digestion and absorption of nucleoproteins, Fractionation, sequencing and chemical synthesis of oligonucleotides.Metabolism of purines - *de novo* and salvage pathways for purine biosynthesis, regulation of biosynthesis of nucleotides.#Purine catabolic pathway#.Metabolism of pyrimidines - biosynthesis and catabolism. .Disorders of purine and pyrimidine metabolism,intermediary metabolism and KEGG pathway.

Self-study portion

Text Books:

T.B.1. Voet, D. and Voet, JG. Biochemistry, 3rd Edition, John Wiley & Son. 2004.

Unit-I	Chapter 17 – Page no 581-618 and Chapter 18 - Page no 626-651. T.B.1.
Unit-II	Chapter 26 –Page no 985-1044. T.B.1.
Unit-III	Chapter 25- Page no 909-969. T.B.1.
Unit-IV	Chapter 28 - Page no 1069-1098. T.B.1.
Unit-V	Chapter 12 - Page no 324-380. T.B.1.

Books for References:

1. Stryer,Biochemistry- Freeman. 5th ed, 2002.
2. Lehninger's, McMillan, Worth, Principles of Biochemistry. 7th ed, Nelson Cox.,2013.

Web Source

1. https://csdb.glycoscience.ru/database/
2. http://www.glycome-db.org/
3. https://www.lipidmaps.org/data/structure/index.php
4. https://www.rcsb.org/
5. https://www.ebi.ac.uk/thornton-srv/software/PROCHECK/

Relationship Matrix for Course Outcomes, Programme Outcomes and Programme Specific Outcomes:

Semester	**Code**		**Title of the Paper**			**Hours**		**Credits**		
I	**20PBT1CC2**		**ADVANCED BIOCHEMISTRY**			**6**		**5**		
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓		✓	✓	✓		✓	✓	✓	✓
CO2	✓		✓	✓	✓			✓	✓	✓
CO3	✓		✓	✓	✓			✓	✓	✓
CO4	✓		✓	✓	✓			✓	✓	✓
CO5	✓	✓	✓	✓	✓	✓		✓	✓	✓
Number of Matches = 38, Relationship : High										

Prepared by:
1. Dr. T. Nargis Begum

-

Checked by:
1.Dr. J. Sebastin Raj

Note:

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very poor	Poor	Moderate	High	Very high

Semester	Code	Course	Title of the Course	Hours	Credits	Max. marks	Internal marks	External marks
I	20PBT1CC3	Core – III	IMMUNOLOGY AND IMMUNOTECHNOLOGY	6	4	100	25	75

Course Outcomes

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

1. Describe the function of the major components and mechanism of the immune system to protect the body from the pathogens
2. Familiar with the immunologic responses involved in preventing, combating infections and the concepts of nonspecific and specific immunity.
3. Resourceful in the structure, function and characteristics of immunoglobulins.
4. Intellectual literacy in the common immune diseases in terms of the underlying basic principles and preventive measures.
5. Familiar in the modern techniques that aids human protection.

UNIT I Components of Immune system: **18 hours**

Immunity: innate immunity-factors,acquired immunity-types, comparison of active and passive acquired immunity.# Haematopoiesis# , Cells of the immune system and their role - lymphoid cells (T and B lymphocytes, NK cells), Macrophages,Dendritic cells, Eosinophils, Basophils, Neutrophils, Mast cells, Antigen presenting cells and Platelets, Organs of the immune system - Primary and secondary lymphoid organs.

UNIT II Antigens, and Antibodies: **18 hours**

Antigens- structure, Types of antigens – factors of antigenicity. T cell and B cell epitopes, hapten, #adjuvants and super antigens#.T dependent and independent antigens. antigenic determinants. Immunogens and chemical nature.Antibodies: Ultra structure of immunoglobulin, types and functions. Monoclonal and polyclonal antibodies and its application. Antibody receptors- T cell receptors (TCR), B cell receptor(BCR).

UNIT III Immune response of B cells and T cells: **18 hours**

B cell - Activation, humoral immune response, T cell - Activation and Cell mediated response, Antigen processing and presentation pathway, Induction of immune response-Cytokines, lymphokinesand chemokines, # Colonel selection Theory and process #, Complement activation – classical and alternative pathways.

UNIT IV Immunity to infectious diseases: **18 hours**

Bacterial, viral Auto immunity: Classification and mechanisms of autoimmune diseases. Structure and functions of class I and class II MHC molecules. Transplantation immunology: types, allograft rejection,Graft versus host reactions, application of transplantation immunology, Principles of tumour immunology: Tumour antigens, immune response to tumour, and immunotherapy of malignancy. Vaccines: classification - inactivated, live attenuated, subunit, #syntheticand DNA vaccine and its importance #.

UNIT V Immunology based techniques and technology: **18hours**

Clinical methods for detection of antigens and antibodies: Immunodiffusion: Ouchterlony analysis (Single radial diffusion), Double immunodiffusion. Immunoelectrophoresis: Immunocontraception. Binder- Ligand assays: RIA, ELISA, Western blot. Histocompatibility testing: HLA typing. Hepatitis – B virus test. # Immune complex detection: Rosettes Forming Array, Plaque Forming Array #.

Self - study portion

Text Books:

1. R. A. Goldsby, T. J.Kindt, B.A.Osborne, J. Kuby. Immunology, 5th Edition, W.H. Freeman and Company, New York, 2003.

2. A. K. Abbas, A. H. Lichtman, S. Pillai. Cellular and Molecular Immunology, 7th Edition, Elsevier Health Sciences.,2011
3. P. M. Latha. A Text Book of Immunology, 1st Edition, S.Chand& Company Ltd, New Delhi,2003.

Books for References:

1. I. Roitt. Essential Immunology, 10th Edition. Blackwell Scientific Publication, 2002.
2. M. R. Pandian and B. S. Kumar. Immunology and Immunotechnology, Panima Publishingcorporation, New Delhi, 2007.
3. D. M. Weir and J. Stewart. Immunology, 10th Edition. Churchill Livingston, New York, 2000.
4. Janis Kuby,Immunology,W.H.Freeman& company, New York. 1997
5. Ivan M. Roitt et al., Essential Immunology, XII Edition, Wiley- Blackwell Publishers,UK, 2010.

Web Source

1. https://www.immunology.org/public-information/what-is-immunology
2. https://en.wikipedia.org/wiki/Immunology
3. https://www.nature.com/subjects/immunology
4. https://www.immunology.org/public-information/bitesized-immunology

Relationship Matrix for Course Outcomes, Programme Outcomes and Programme Specific Outcomes:

Semester	**Code**			**Title of the Paper**			**Hours**		**Credits**
I	**20PBT1CC3**			**IMMUNOLOGY AND IMMUNOTECHNOLOGY**			**6**		**4**
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓		✓	✓		✓	✓		✓
CO2	✓			✓	✓		✓	✓	✓	✓
CO3	✓		✓	✓	✓		✓	✓	✓	✓
CO4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO5	✓	✓			✓	✓	✓	✓	✓	✓
Number of Matches = 40, Relationship : High										

Prepared by:
1.H.F.SeyedMafiyaHaniff

Checked by:
1.Dr. S. Benazir Begum

Note:

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very poor	Poor	Moderate	High	Very high

Semester	Code	Course	Title of the Course	Hours	Credits	Max. marks	Internal marks	External marks
I	20PBT1CC4P	Core – IV	BIOINSTRUMENTATION, ADVANCED BIOCHEMISTRY, IMMUNOLOGY AND IMMUNOTECHNOLOGY - PRACTICAL	6	4	100	20	80

Course Outcomes

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

1. Describe how scientific methods and instruments are used to explain natural phenomena.
2. Generate hypotheses, evaluate data, and design experiments to investigate a scientific problem.
3. Gain expertise in handling equipment for electrophoresis, spectrophotometer and chromatography.
4. Gain skill-based knowledge on techniques associated with Biochemistry
5. Develop their skills in the understanding of immunological reactions.

List of Practicals:

1. Validating Lambert – Beer's law using KMnO4. Demonstration
2. Absorption spectra of proteins/pigment.
3. Paper chromatography.
4. column chromatography
5. Thin layer chromatography.
6. Extraction and Estimation of sugar from natural sources – glucose.
7. Extraction and Estimation of protein by Lowry's method.
8. Estimation of amino acid by Ninhydrin method
9. Estimation of serum cholesterol by Zak's method.
10. Quantitative analysis of blood urea/ creatinine
11. Quantitative analysis of sugar in urine by Benedict's reagent
12. Blood Grouping and agglutination.
13. Total count, Differential count (RBC & WBC)
14. Ouchterlony double diffusion.
15. Immunoelectrophoresis.
16. ELISA

Text Books:

1. Keith Wilson and John Walker, Biochemistry - Practical Approach, 5TH edition,2000.

2.Collins and Lyne's Microbiological methods, 3rd edition, Butterworth-Heinemann Ltd,1995.

3. R. A. Goldsby, T. J. Kindt, B. A. Osborne, J. Kuby. Immunology, 5th Edition.W.H.Freeman andCompany, 2003.

Books for Reference:

1. J. Jayaraman, Laboratory manual in Biochemistry,2nd edition, New Age International Publishers,2011.
2. L. Robert, Switzer and Liam Garrity. Experimental Biochemistry,2nd edition, W.H.Freeman and Company, New York. 2001.

Web Source

1. https://link.springer.com/chapter/10.1007/978-981-10-8186-
2. https://www.youtube.com/watch?v=BST5GRsAnPk

Relationship Matrix for Course Outcomes, Programme Outcomes and Programme Specific Outcomes:

Semester	Code	Title of the Paper	Hours	Credits
I	20PBT1CC4P	BIOINSTRUMENTATION, ADVANCED BIOCHEMISTRY, IMMUNOLOGY AND IMMUNOTECHNOLOGY - PRACTICAL	6	4

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓	✓	✓	✓			✓	✓	✓
CO2	✓	✓	✓	✓			✓	✓	✓	✓
CO3	✓	✓	✓			✓		✓	✓	✓
CO4	✓	✓	✓					✓	✓	✓
CO5	✓	✓	✓	✓	✓			✓	✓	✓
Number of Matches = 37, Relationship : High										

Prepared by:
1. Dr.B.NazeemaBanu

Checked by:
1.Dr. J. Sebastin Raj

Note:

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very poor	Poor	Moderate	High	Very high

Semester	Code	Course	Title of the Course	Hours	Credits	Max. marks	Internal marks	External marks
I	20PBT1DE1A	DSE - I	BIODIVERSITY AND BIOPROSPECTING	6	4	100	25	75

Course Outcomes

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

1. Ensure imparting the knowledge on a concept of biodiversity and its advantages.
2. Identify the application of micro and macro algae in different sectors.
3. Determine the category and potentialities of biological products.
4. Improve the new discovery and commercialization of new products based on biological resources.
5. Appraise the resources or compounds can be important for and useful in many fields, including pharmaceuticals, agriculture.

Unit I: Components of Biodiversity: **18 hours**

Biodiversity crisis and biodiversity loss.Importanceof biodiversity in daily life. Biodiversity and climate change. Types of Ecosystems: India as mega biodiversity Nation. Hot spots and biodiversity in India. Biodiversity and Ecosystem functioning.Biotechnology and Conservation; IUCN red list of threatened species; Germplasm, #National Parks, Botanical Gardens, Wildlife Sanctuaries#.

Unit II:Bioprospecting of micro-algae: **18 hours**

Phyco-remediation, Animal feed, feedstock for anaerobicprocesses, algal vaccines, algal biofuels, biological hydrogen production from algae,biofertilizer, Lipid identification and extraction techniques, other value added products frommicroalgae (Pigments, vitamins, food supplements, fatty acids), cosmetics, applications ofspent biomass, diatomaceous earth in industries.#Antimicrobial and anticancer compounds from microalgae#.

Unit III: Bioprospecting of macro-algae: **18 hours**

Bioprospecting of marine algae, Present and future prospects of seaweeds in developing functional foods, bioactive metabolites from seaweeds, *In-vivo* and *in-vitro* studies of seaweed compounds, chemical ecology of seaweeds,anticoagulant effect.Conventional and alternative technologies for the extraction of algal polysaccharides, (alginates, agar, carrageenan), #Phlorotannins#.

Unit IV: Bioprospecting of Fungi: **18 hours**

An arbuscular mycorrhiza fungi and their application in forestry, agroforestry and restoration/ reclamation of wasteland. Therapeutic proteins from fungi, bioactive compound from endophytic fungi.Medicinal fungi: antibiotics from fungi, Product of pharmaceutical importance of fungi,#Fungi as biosensors#, industrially important fungal enzymes.

Unit V: Bioprospecting of plants: **18 hours**

Cellulose, lignin, starch, waxes, suberins, rubber – Their chemicaldiversity, localisation and uses.Other useful plant products – Oils, pigments, phenolics, terpenoids, alkaloids,enzymes, antibiotics, antiviral agents; Immunosuppressive agents and other therapeutic agents.#Biopharmaceuticals#, Anticancer compounds from plants, Green synthesis of nanoparticles and its uses.

Self - study portion

Text Books:

1. R. A. Andersen, Algal Culturing Techniques. Elsevier Academic Press, 2005.
2. L. Barsanti and P. Gualtieri, Algae: Anatomy, Biochemistry and Biotechnology. CRC Press, 2006.
3. E. E Benson. Plant Conservation Biotechnology.Taylor & Francis, 2012.
4. D. Bhattacharya. Origin of Algae and Their Plastids. Springer-Verlag, New York, 2013.

Books for Reference:

1. E.D. and U. Sommer, Seaweeds biology-Novel insights into ecophysiology, ecology and utilization. Springer-Verlag, 2012.
2. H. Dominguez, Functional ingredients from algae for foods and nutraceuticals. Woodhead Publishing Ltd., U K., 2013.
3. V. Evangelista, L. Barsanti, A. M. Frassanito, V. Passarelli, and P. Gualtieri, Algal toxins: nature, occurrence, effect and detection. Springer, 2008.
4. R. K. Gupta and V. D. Pandey . Advances in Applied Phycology. Daya Publishing House, Delhi, 2007.

Web Source

1. https://nptel.ac.in/courses/102104068/

Relationship Matrix for Course Outcomes, Programme Outcomes and Programme Specific Outcomes:

Semester	**Code**			**Title of the Paper**				**Hours**		**Credits**
I	**20PBT1DE1A**			**BIODIVERSITY AND BIOPROSPECTING**				**6**		**4**
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓		✓	✓	✓	
CO3			✓	✓	✓	✓	✓	✓	✓	✓
CO4				✓	✓	✓	✓	✓	✓	✓
CO5	✓	✓			✓	✓	✓	✓	✓	✓
Number of Matches = 41, Relationship : High										

Prepared by:
1. Dr. J. Sebastin Raj

-

Checked by:
1. Dr. Y. ArsiaTarnam

Note:

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very poor	Poor	Moderate	High	Very high

Semester	Code	Course	Title of the Course	Hours	Credits	Max. marks	Internal marks	External marks
I	20PBT1DE1B	DSE - I	BIOFERTILIZER TECHNOLOGY	6	4	100	25	75

Course Outcomes

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

1. Ensure imparting the knowledge of chemical based agriculture.
2. Identify the application of biofertilizer and organic farming.
3. Determine the category of chemical fertilizers and organic manures.
4. Improve the new live products (or latent cells of microbes) and require care in storage, transport, application and maintaining field conditions
5. Develop skills management for best results uses both nitrogenous and phosphate bio fertilizers.

UNIT I: Introduction to Biofertilizers **18 hours**

Structure and characteristic features of the following biofertilizer organisms: Bacteria: Azospirillum, Azotobacter, Bacillus, Pseudomonas, Rhizobium and Frankia. Cyanobacteria: Anabaena, Nostoc, Hapalosiphon. Fungi: Glomus, Gigaspora, Sclerocystis, #Amanita, Laccaria#.

UNIT II: Biofertilization processes **18 hours**

Decomposition of organic matter and soil fertility and vermicomposting.Mechanism of phosphate solubilization and phosphate mobilization.Nitrogen fixation - Free living and symbiotic nitrogen fixation.#Biotechnological application in nitrogen fixation#.

UNIT III: Nitrogenous Biofertilizers **18 hours**

Bacteria - Isolation and purification of Azospirillum and Azotobacter, mass multiplication of Azospirillum and Azotobacter, formulation of inoculum of Azospirillum and Azotobacter, application of inoculants of Azospirillum and Azotobacter. Isolation and purification of Rhizobium, mass multiplication and inoculum production of Rhizobium, #Methods of application of Rhizobium inoculants#.

UNIT IV: Mycorrhizae Biofertilizers: **18 hours**

Mycorrhizae - Ecto and endomycorrhizae and their importance in agriculture. Isolation of AM fungi - Wet sieving method and sucrose gradient method. Mass production of AM inoculants and field applications.Isolation and Purification of phosphate solubilizers. Mass multiplication and field applications of phosphate solubilizer (Pseudomonas striata). Biofertilizers -# Storage, shelf life, quality control and marketing#.

UNIT V: Organic farming: **18 hours**

Management of organic waste and green manure-Farm manures, composts .Organic manures-organic residue, chemical nature of organic manure, #green manure, importance of green manure#.Animal based organic manure - cow dung, poultry waste, Production of vermicompost and Panchakavya, production and commercialization of Organic products.

##Self-study portion

Text Books:

1.L.L Somani, S.C. Bhandari, K.K. Vyas and S.N. Saxena. Biofertilizers, Scientific Publishers – Jodhpur, 1990.

2.N.S.Subba Rao, G.S. Venkataraman and S. Kannaiyan. Biological nitrogen fixation, ICAR Pub., New Delhi,1993.

Books for Reference:

1. D.J. Bagyaraj and A. Manjunath. Mycorrhizal symbiosis and plant growth, Univ. of Agricultural Sciences, Bangalore, India, 1990.
2. S.S. Purohit, P.R. Kothari and S.K. Mathur. Basic and Agricultural Biotechnology, Agro Botanical Pub. India,1993.
3. N. S.Subba Rao, Biological nitrogen fixation: recent developments, Mohan Primlani for Oxford and IBH Pub. Co. (P) Ltd., India, 1988.

Web Source

1. https://elearninguoa.org/course/bioferilizer technology/agricultural-biotechnology
2. www.sintef.no/en/nitrogen fixation
3. www.edx.org/learn/mycorrhizal.og

Relationship Matrix for Course Outcomes, Programme Outcomes and Programme Specific Outcomes:

Semester	Code			Title of the Paper				Hours		Credits
I	20PBT1DE1B			BIOFERTILIZER TECHNOLOGY				6		4
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓		✓	✓	✓		✓	✓	✓	✓
CO2	✓		✓	✓	✓			✓	✓	✓
CO3	✓		✓	✓	✓			✓	✓	✓
CO4	✓		✓	✓	✓			✓	✓	✓
CO5	✓	✓	✓	✓	✓	✓		✓	✓	✓
Number of Matches = 38, Relationship : High										

Prepared by:
1. Dr.K.Gobalan

-

Checked by:
1. Dr. J. Sebastin Raj

Note:

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very poor	Poor	Moderate	High	Very high

Semester	Code	Course	Title of the Course	Hours	Credits	Max. marks	Internal marks	External marks
II	20PBT2CC5	Core - V	ENZYMOLOGY AND ENZYME TECHNOLOGY	6	5	100	25	75

Course Outcomes

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

1. Acquire the knowledge about history,classification,purification and separation of enzymes
2. Intellectual about enzyme kinetics.
3. Describe the mechanism of enzyme action.
4. Construct the knowledge on enzyme regulation.
5. Appraise about the techniques of immobilization and application in enzymes in industries.

Unit I:Historical aspects of enzymology: **18 hours**

History, nomenclature and classification of enzymes, according to IUB-EC-1964.Intracellular localization of enzymes, isolation and fractionation of enzymes - classical methods of purification and crystallization, criteria of purity, units of enzyme activity. Turn over number, specific activity. #Active site definition, organization and determination of active site residues#.

Unit II:Kinetics of catalyzed reaction: **18 hours**

Single substrate reactions, bisubstrate reactions, Concept and derivation of Michaelis – Menten equation, Lineweaverburk plot, Briggs Haldane relationship. Determination and significance of kinetic constants, Limitations of Michaelis-Menten Kinetics.Inhibition kinetics - competitive, non-competitive and uncompetitive.#Allosteric inhibition, cooperative, cumulative, feedback inhibition#.

Unit III:Mechanism of enzyme catalysis: **18 hours**

Collision & transition state theories, specificity of enzymes. Proximity and orientation effects, general acid-base catalysis, covalent and electrostatic catalysis - nucleophilic and electrophilic attacks, catalysis by distortion, metal ion catalysis.Theories on mechanism of catalysis. Coenzymes - structure and function, Mechanism of enzymes action: mechanism of action of lysozyme and chymotrypsin. #Isoenzymes#.

Unit-IV: Enzyme Regulation: **18 hours**

General mechanisms of enzyme regulation, Reversible (glutamine synthase & phosphorylase) and irreversible (proteases) covalent modifications of enzymes.Mono cyclic and multicyclic cascade systems with specific examples.Allosteric enzymes, qualitative description of "concerted" & "sequential" models for allosteric enzymes.#Proteinligand binding measurement, analysis of binding isotherms#.

Unit V:Applications of enzymes in Industry: **18 hours**

Immobilization and Immobilized enzymes.Various methods of immobilization - ionic bonding, adsorption, covalent bonding (based on R groups of amino acids), microencapsulation and gel entrapment.Applications of immobilized enzymes. Biosensors – glucose oxidase, cholesterol oxidase, urease and antibodies as biosensors. Abzymes and Ribozymes.Enzymes of clinical importance - diagnostic significance and therapeutic effects.#Enzyme Engineering#.

 # # Self - study portion

Text Books:

1. Zubay, Principles of Biochemistry –4th ed, William C.Brown Publication 1998.
2. Palmer. Understanding enzymes.Prentice Hall. 2004.

Books for Reference:

1. Donald Voet and Judith G. Voet..Biochemistry.3rd Edition. John Wiley, New York, 2004
2. Allan Fershi, Enzyme structure and mechanism. 2nd Edition.W.H.Freeman& Co. Ltd., USA, 1984.

Web Source

1. https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/104105076/lec8.pdf

Relationship Matrix for Course Outcomes, Programme Outcomes and Programme Specific Outcomes:

Semester	**Code**			**Title of the Paper**				**Hours**		**Credits**
II	**20PBT2CC5**			**ENZYMOLOGY AND ENZYME TECHNOLOGY**				**6**		**5**
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓		✓	✓	✓		✓	✓	✓	✓
CO2	✓		✓	✓	✓			✓	✓	✓
CO3	✓		✓	✓	✓			✓	✓	✓
CO4	✓		✓	✓	✓			✓	✓	✓
CO5	✓	✓	✓	✓	✓	✓		✓	✓	✓
Number of Matches = 38, Relationship : High										

Prepared by: **Checked by:**

1. Dr. T. Nargis Begum - 1.Dr. J. Sebastin Raj

Note:

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very poor	Poor	Moderate	High	Very high

Semester	Code	Course	Title of the Course	Hours	Credits	Max. marks	Internal marks	External marks
II	20PBT2CC6	Core - VI	MOLECULAR BIOLOGY AND GENETIC ENGINEERING	6	5	100	25	75

Course Outcomes

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

1. Outline and examine the mechanism of DNA replication and translation.
2. Critically assess and predict the mechanism of gene expression and gene regulation
3. Examine the appropriate selection and screening technique for a specific recombined DNA.
4. Describe the applications of genetic engineering in microbial and animal improvement along with the ethical guidelines
5. Demonstrate the specific techniques for developing transgenic plants and its Biosafety.

UNIT I Basics of cell and molecular Biology: 18 hours

cell structure and function, Cell cycle and control, DNA structure and chromosome, Role of genes within cells, genetic code, genetic elements that control gene expression, Nucleic acids and DNA replication:DNA - structure, different forms, denaturation, renaturation, #circular and superhelical structures#. RNA - structure, classes and functions. Replication - Process, Semiconservative andDiscontinuous replication.

UNIT II: Transcription and Translation: 18 hours

Transcription - Initiation, Elongation and Termination, Transcriptional factors, Transcription in Eukaryotes, alternative splicing, mRNA transport. Translation - Protein synthesis - Initiation, Elongation and Termination. Post-transcriptional and translational modification of proteins, #Translational control#, genetic code.

UNIT III 18 hours

Regulation of gene expression and Transposable elements: Operon systems: Lactose operon - induction & repression. Tryptophan operon - Repression & attenuation, #Arabinose operon#. Mutations - biochemical basis, Spontaneous mutations, Isolation of mutants, Mutagenesis, Reversion and Suppression. Transposons and Transposable elements.

UNIT IV Protein Localization and DNA repair: 18 hours

Export of secretory proteins – chaperons (HSP) - signal hypothesis, transport and localization of proteins to mitochondria, chloroplast, peroxisomes and membrane, #Nuclear localization signals#. DNA Repair - DNA damage and repair mechanisms - Photoreactivation, excision repair, recombination repair and SOS repair.

UNIT V Genetically engineered Microorganism, plants and animals: 18 hours

Aim and scope of genetic engineering (GE),methodology and tools of Genetic engineering , Inocula for agricultural uses and pollution control, GMO for production of antibiotics, enzymes, insulin, growth hormones, monoclonal antibodies and single cell protein, Genetic engineering for plant and animal improvement, #Ethical committee regulations and guidelines for the use of Genetically engineered microbes, plants and animals#.

Self-study Portion

Text Books:

T.B-1D. Freifelder. Molecular Biology, 2nd Edition, Jones and Barlett Publishers, 2004.
T.B-2 Nicholl, Introduction to Genetic Engineering,3rd edition, Cambridge University Press, 2008.
T.B-3S. B. Primrose and R. M. Twyman. Principles of gene manipulation and Genomics,7th edition, Blackwell Scientific Publications, 2006.

Unit I Chapter - 9, Page No. 223-273,TB.1.
Unit II Chapter - 12, 13, 14, Page No. 315-450, TB.1
Unit IIIChapter - 2, Page No. 106-114. TB.1, Chapter - 10, Page No. 277-292, TB.3
Unit IV Chapter - 19, Page No. 619-639. TB.3, Chapter - 5,6,7,8, Page No. 243- 375.TB.1,
Unit VChapter - 15, Page No. 453-497. TB.2, Chapter - 10, Page No. 179-206.TB.1,

Books for Reference:

1. J. D. Watson, T. A. Baker, S. P. Bell, A. Gann, M. Levine, R. Losick. Molecular Biology of the gene, 5th Edition, Pearson Education, Inc. 2004.
2. G. Karp Cell and Molecular Biology: Concepts and Experiments, John Wiley and Sons Inc. 2009.
3. Genes IX - Benjamin Lewis. Oxford University & Cell Press, 2008. Unit 1: TB.1, Chapter - 4, Page No. 79-112, Chapter - 12 & 13, Page No. 333-337, 379.

Web Source

1. https://geneticscertificate.stanford.edu/courses/genetic-engineering-and-biotechnology
2. https://study.com/articles/Genetic_Engineering_Courses_and_Classes_Overview.html
3. https://www.edx.org/learn/genetic-engineering
4. https://nptel.ac.in/content/syllabus_pdf/102103013.pdf

Relationship Matrix for Course Outcomes, Programme Outcomes and Programme Specific Outcomes:

Semester	**Code**			**Title of the Paper**				**Hours**		**Credits**
II	**20PBT2CC6**			**GENETIC ENGINEERING AND MOLECULAR TECHNIQUES**				**6**		**5**
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓	✓	✓		✓		✓	✓	✓
CO2	✓	✓	✓	✓		✓		✓	✓	✓
CO3	✓	✓	✓	✓		✓		✓	✓	✓
CO4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO5	✓	✓	✓	✓	✓	✓		✓	✓	✓
Number of Matches = 43, Relationship : High										

Prepared by:
1. Dr.B.NazeemaBanu

Checked by:
1.Dr. J. Sebastin Raj

Note:

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very poor	Poor	Moderate	High	Very high

Semester	Code	Course	Title of the Course	Hours	Credits	Max. marks	Internal marks	External marks
II	20PBT2CC7	Core - VII	RECOMBINATION DNA TECHNOLOGY	6	4	100	25	75

Course Outcomes

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

1. Explain the principles of enzymes and vector which serves indispensable tools in recombinant DNA technology.
2. Demonstrate the principle and the concept of cloning strategies.
3. Develop skills associated with constructing cDNA libraries and finding right clone.
4. Discuss the mechanism associated with PCR and sequence analysis.
5. Understand the genome editing and societal concerns of recombinant DNA technology.

UNIT I Basic techniques involved in rDNA technology: 18 hours

Enzymes used in cloning: Restriction enzymes - specificity, sticky and blunt ends, isoschizomers, processing of restriction fragments; DNA ligase – optimizing ligating conditions; alkaline phosphatase; double digest; modification of restriction fragment ends - trimming and filling, linkers and adapters, homopolymer tailing; #other ways of joining DNA molecules – TA cloning of PCR products and DNA topoisomerase#.

UNIT II Vectors: 18 hours

Plasmid vectors – properties of plasmid vectors, plasmid replication and transformation; Lambda vectors – biology of lamba phage; invitro packaging, insertion vectors – gt10, replacement vectors – EMBL4; cosmids; M13 vectors; expression vectors - pGEM; YEp; YCp; YIp and mammalian cell vectors; #YAC and BAC#.

UNIT III Genomic and cDNA Libraries: 18 hours

Genomic library – partial digest, choice of vectors, construction and evaluation of genomic library; growing and storing of libraries; cDNA library – isolation of mRNA, cDNA synthesis#, bacterial cDNA; #random, ordered and arrayed libraries#.

UNIT IVFinding the right clone: 18 hours

screening libraries with gene probes – hybridization, labeling probes, steps in hybridization, screening procedure, probe selection; screening expression libraries with antibodies; rescreening; subcloning; characterization of plasmid clones – restriction digest and #agarose gel electrophoresis, southern blot#, PCR and its types.

UNIT V Genome Editing: 18 hours

Definition, process - zinc finger nucleases, transcription activator – like effector nuclease, CRISPR/Cas9 mechanism and its applications. Overview on rDNA Biosafety guidelines – IPR, recombinant DNA advisory committee, institutional Biosafety committee, #review committee on genetic manipulation and genetic engineering approval committee#.

Self Study portion

Text Books:

T.B 1 Jeremy W Dale and Malcom von Schantz, From Genes to Genomes: Concepts and Applications of DNA Technology, John Wiley & Sons, Ltd. 2002.

T.B 2 Bernard R. Glick, Jack J. Pasternak, Cheryl L. Patten, Molecular Biotechnology-principles and applications of Recombinant DNA, 4th edition, ASM press, Washington DC, 2010.

UNIT I Chapter 5 Section 5.1 – 5.6 T.B. 1 and Chapter 3 T.B. 2
UNIT II Chapter 6 Section 6.1 – 6.7 T.B. 1 and Chapter 3 T.B. 2
UNIT III Chapter 7 Section 7.1 – 7.4 T.B. 1
UNIT IV Chapter Section 8.1 – 8.5 T.B. 1 and Chapter 4 T.B. 2
UNIT V Chapter 11 Section 11.1 – 11.3 T.B. 1 and Chapter 10 T.B. 2; Chapter 22 & 23 T.B. 2

Books for Reference:

1. T.A. Brown, Gene cloning and DNA analysis: anIntroduction. John Wiley & Sons, 2016.
2. S.B. Primrose and R. Twyman, Principles of Gene Manipulation and Genomics.John Wiley & Sons, 2013.
3. J.W. Dale, M. Von Schantz and N. Plant, From genes to Genomes: Concepts and Applications of DNA Technology. John Wiley & Sons, 2012.
4. V.A. Saunders, Microbial Genetics Applied to Biotechnology: Principles and Techniques of Gene Transfer and Manipulation. Springer Science & Business Media, 2012.

Web Source

1. https://nptel.ac.in/courses/102103013/
2. https://genomebiology.biomedcentral.com/articles/10.1186/s13059-018-1586-y

Relationship Matrix for Course Outcomes, Programme Outcomes and Programme Specific Outcomes:

Semester	Code			Title of the Paper			Hours		Credits	
II	20PBT2CC7			RECOMBINATION DNA TECHNOLOGY			6		4	
Course Outcomes (COs)	Programme Outcomes(POs)					Programme Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓		✓	✓		✓		✓	✓	
CO2	✓		✓	✓	✓	✓		✓	✓	✓
CO3	✓	✓	✓		✓	✓	✓	✓		✓
CO4	✓	✓				✓	✓			
CO5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Number of Matches = 36, Relationship : High										

Prepared by:
1. Dr. Y. ArsiaTarnam

Checked by:
1. Dr. J. Sebastin Raj

Note:

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very poor	Poor	Moderate	High	Very high

Semester	Code	Course	Title of the Course	Hours	Credits	Max. marks	Internal marks	External marks
II	20PBT2CC8P	Core - VIII	ENZYMOLOGY AND ENZYME TECHNOLOGY, MOLECULAR BIOLOGY AND GENETIC ENGINEERING & RECOMBINANT DNA TECHNOLOGY – PRACTICAL	6	4	100	20	80

Course Outcomes

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

1. Discuss the basic knowledge of enzymes, its components and their functional properties.
2. Exposure of wide applications of enzymes and their future potential.
3. Technical know-how on versatile techniques in recombinant DNA technology.
4. Describe the mechanism of action and the use of restriction enzymes in biotechnology research
5. Proficiency in designing and conducting experiments involving genetic manipulation.

List of Practicals:

1. Extraction and estimation of enzymes (peroxidase and catalases) from either plant or microbial source
2. Determination of effect of pH on the activity of enzyme.
3. Determination of effect of temperature on the activity of enzyme.
4. Determination of effect of substrate concentration on the activity of enzyme.
5. Determination of effect of enzyme concentration on the activity of enzyme.
6. Isolation andQuantification of genomic DNA from bacteria.
7. Isolation and Quantification of plasmid DNA from bacteria.
8. Agarose gel electrophoresis.
9. Restriction digestion and ligation.
10. Preparation of *E.coli* competent cells and Transformation.
11. SDS– PAGE/Native PAGE.
12. Western blot – Demonstration.
13. Polymerase chain reaction (PCR).

Text Books:

1. James G. Cappuccino and Natalie Sherman.Microbiology: A laboratory Manual. 10th Edition,Benjamin Cummings. 2013.
2. J. Sambrook and D.W. Russel, Molecular Cloning: A Laboratory Manual, Vols (1-3), CSHL, 2001.

Book for Reference:

1. Hans Bisswanger, Practical Enzymology, Second Edition, Wiley-VCH Verlag GmbH & Co.2012.

Web Source

1. https://www.kau.edu.sa/Files/0016333/Subjects/Enzymology%20BIOC231.pdf.
2. https://www.youtube.com/watch?v=S-6177IEUMo.

Relationship Matrix for Course Outcomes, Programme Outcomes and Programme Specific Outcomes:

Semester	**Code**			**Title of the Paper**		**Hours**			**Credits**
II	**20PBT2CC8P**			**ENZYMOLOGY AND ENZYME TECHNOLOGY, MOLECULAR BIOLOGY AND GENETIC ENGINEERING & RECOMBINANT DNA TECHNOLOGY – PRACTICAL**		**6**			**4**
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓	✓	✓	✓			✓	✓	✓
CO2	✓	✓		✓				✓	✓	✓
CO3	✓	✓	✓	✓		✓	✓	✓	✓	✓
CO4	✓	✓	✓			✓	✓	✓	✓	✓
CO5	✓	✓		✓	✓	✓	✓		✓	✓
Number of Matches = 36, Relationship : High										

Prepared by:
1.H.F.SeyedMafiyaHaniff

Checked by:
1.Dr.B. NazeemaBanu

Note:

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very poor	Poor	Moderate	High	Very high

Semester	Code	Course	Title of the Course	Hours	Credits	Max. marks	Internal marks	External marks
II	20PBT2DE2A	DSE - II	GENOMICS AND PROTEOMICS	6	4	100	25	75

Course Outcomes

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

1. Understand the advanced level of genomes and their expressions from structure to functional level.
2. Explain the principle of genome through the process of plant and animal technology and computational analysis.
3. Develop skill proteomics andthe different approaches to analyses the proteomics.
4. Determine the different concepts of microarry and their analysis.
5. Asses the pharmacogenomics and Pharmacogenetics, drug design.

UNIT- I Genome Structure: 18 hours

Genome sizes- microbial and organelle genomes - Centromeres and telomeres, tandem repeats- dispersed repeats (transposons). Basic Sanger sequencing - automated sequencing- sequencing simple genomes - Sequencing large genomes - finalizing sequences – #resequencing and Next generation sequencing (NGS)#.

UNIT- II Microarray: 18 hours

DNA Micro array, Protein Micro array Transcriptomics, Applications and advantages of Micro arrays- DNA chips and SAGE technology- Organization of genome projects- human, plant, animal and microbial genome. Microarray-design- analysis visualization of data-Tools for microarray analysis- MADAM-Gene.#Applications of Microarrays#.

UNIT- III Human Genome: 18 hours

Characteristics of human-genome sequence important genes associated with each chromosome - Mendelian and sex-linked traits in human inheritance. Genetic diseases due to defects in autosomal and sex linked genes. Whole genome sequencing – #Human Genome Project#.

UNIT- IV Proteomics: 18 hours

Identifying proteins in complex mixtures: Protein profiling, quantitative 2D GE, multidimensional chromatography, quantitative mass spectrometry, MALDI – TOF, TOF analysis and analytical protein chips.Protein structure databanks- #protein databank#.

UNIT- V Phamacogenomics and New Drug Design: 18 hours

Introduction to drug design and developing new drugs: Procedure followed in drug design; Molecular modification of lead compounds; Prodrug and soft drugs; Physico-chemical parameters in drug design; QSAR. #Protein-protein interaction#.

Self-study portion

Text Books:

1. Necia Grant Cooper; (Ed.). The Human Genome Project; Deciphering theblueprint of Heredity University Science books, CA, USA.1994.

2. Gary Zweiger. Transducing the Genome; Information, Anarchy and Revolution in Biomedical Sciences. Tata McGraw-Hill Publishers, New Delhi.2003.
3.C.Branden, and J.Troze. Introduction toProtein Structure. Second Edition.Garland Publishing, New Delhi.1999.
4.W.E. Evans and M.V. Relling. Pharmacogenomics: translating functional genomics into rational therapeutics. *Science* 286:487.1999.

Books for Reference:

1. A.D.Baxevanis, and B.F.F. Ouellette.Eds. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. Wiley Interscience. New York.2001.
2. D Higgins, and W.Taylor (Eds). Bioinformatics: Sequence,Structure and Databnks.Oxford University Press, Oxford.2000.

Web Source

1. https://www.kau.edu.sa/Files/0016333/Subjects/Genomics and protemics%20BIOC231.pdf.

2.https://www.youtube.com/watch?v=S-6177IEUMo

Relationship Matrix for Course Outcomes, Programme Outcomes and Programme Specific Outcomes:

Semester	**Code**			**Title of the Paper**				**Hours**		**Credits**
II	**20PBT2DE2A**			**GENOMICS AND PROTEOMICS**				**6**		**4**
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓	✓	✓		✓		✓	✓	✓
CO2	✓	✓	✓	✓		✓		✓	✓	✓
CO3	✓	✓	✓	✓		✓		✓	✓	✓
CO4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO5	✓	✓	✓	✓	✓	✓		✓	✓	✓
Number of Matches = 43, Relationship : High										

Prepared by:
1. Dr.K.Gobalan

Checked by:
1. Dr.B.NazeemaBanu

Note:

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very poor	Poor	Moderate	High	Very high

Semester	Code	Course	Title of the Course	Hours	Credits	Max. marks	Internal marks	External marks
II	20PBT2DE2B	DSE - II	BIOPHARMACEUTICALS IN NANOMEDICINE	6	4	100	25	75

Course Outcomes

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

1. Provide a comprehensive introduction to biopharmaceuticals in nanomedicine
2. Gain an understanding of producing novel nano biologics and Nanopharmaceuticals
3. Categorize and explain the role of Regenerative medicine and tissue engineering
4. Develop their understanding of biological therapies.
5. Expand their knowledge on Ethical, Safety and regulatory issues of Nanomedicine

UNIT I Pharmaceuticals, Biologics and Biopharmaceuticals: 18 hours

Pharmaceutical products, biopharmaceuticals and pharmaceutical Biotechnology, history of pharmaceutical industry, the age of Biopharmaceuticals, Biopharmaceuticals: current status and future prospects, traditional pharmaceuticals of biological origin, distinction between chemical drugs versus biopharmaceuticals, #sources and delivery of biopharmaceuticals#.

UNIT II Nanopharmaceuticals: 18 hours

Nanobiotechnology for drug discovery - gold nanoparticles and nanolasers for drug discovery.Nanobiotechnology based drug development – Dendrimers as drugs, fullerenes as drug candidates and nanobodies. Nanobiotechnology and drug delivery devices - coating of implants by ultrafine layers of polymers, #nanochips for drug delivery#.

UNIT III Regenerative medicine and tissue engineering: 18 hours

Targeted drug delivery,Nanobiotechnology in tissue engineering - three dimensional nanofilament based scaffolds. Nanobiotechnology for organ replacement and assisted function - Exosomes for drug free organ transplants, Nanotechnology based human nephron filter for renal failure and #Blood-compatible membranes for renal dialysis#.

UNIT IV 18 hours

Role of Nanotechnology in biological therapies – Nanobiotechnology for vaccine delivery, nanobiotechnology and cell transplantation, nanobiotechnology in stem cell based therapies, Nanoparticle mediated gene therapy and nanorod gene therapy, nanocarriers for simultaneous delivery of anticancer drugs, #dendrimers for antisense drug delivery#.

UNIT VEthical, Safety and regulatory issues of Nanomedicine: 18 hours

Ethical, legal and social implications of Nanomedicine (Nanoethics), safety concerns about nanobiotechnology – toxicity of Nanoparticles, fate of Nanoparticle in the human body, measures to reduce toxicity of Nanoparticles, #public perception of safety and future potentials of Nanomedicine#.

Self-study Portion

Text Books:

T.B.1. Gary Walsh.Biopharmaceuticals – Biochemistry & Biotechnology.2nd Edition, John Wiley & Sons. 2003.

T.B.2. Kewal K. Jain.The Handbook of Nanomedicine.3rd edition, Humana Press, 2008.

Unit I Chapter 1, Page no: 1-40. T.B.1.
Unit II Page no: 119-160. T.B.2
Unit III Page no: 303-327. T.B.2
Unit IV Page no: 161-181. T.B.2
Unit V Page no: 329-352. T.B.2

Books for Reference:

1. Christof M. Niemeyeand Chad A. Mirkin, Nanobiotechnology: Concepts, Applications and Perspectives. 1st edition. Wiley-VCH. 2004.

Web Source

1. https://elearninguoa.org/course/health-nanotechnology-nanomedicine/nanotechnology-and-nanomedicine
2. www.sintef.no/en/biopharmaceuticals-medical
3. www.edx.org/learn/nanotechnology

Relationship Matrix for Course Outcomes, Programme Outcomes and Programme Specific Outcomes:

Semester	**Code**			**Title of the Paper**			**Hours**		**Credits**	
II	**20PBT2DE2B**			**BIOPHARMACEUTICALS IN NANOMEDICINE**			**6**		**4**	
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓	✓	✓				✓	✓	✓
CO2	✓	✓	✓	✓			✓	✓	✓	✓
CO3	✓	✓	✓		✓	✓	✓	✓	✓	✓
CO4	✓	✓	✓	✓				✓	✓	✓
CO5	✓	✓	✓	✓	✓			✓	✓	✓
Number of Matches = 39, Relationship : High										

Prepared by
1. Dr.B.NazeemaBanu

Checked by:
1. H.F. SeyedMafiyaHaniff

Note:

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very poor	Poor	Moderate	High	Very high

Semester	Code	Course	Title of the Course	Hours	Credits	Max. Marks	Internal marks	External marks
III	20PBT3CC9	Core – IX	PLANT BIOTECHNOLOGY	6	5	100	25	75

Course Outcomes

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

1. Describe the basic principles and techniques involved in plant tissue culture.
2. Develop the skills associated with endangered plants conservation and the importance of cell culturetechniques in medical and biochemical research.
3. Demonstrate industry appropriate applications of plant biotechnology in agricultural field.
4. Develop the gene transformation techniques in modern agricultural practices and beneficiaries in genetically modified foods.
5. Analyze the achievements in modern agriculture and pharmaceutical industry.

UNIT I: 18 hours

Introduction to plant tissue culture: History of Plant tissue culture - Tissue culture media Murashige and Skoog - Plant Growth Regulators, Micropropagation - Direct and Indirect Organogenesis; Hardening and acclimatization; Somatic embryogenesis -Embryo culture and embryo rescue - Artificial seeds.Cryopreservation and germplasm conservation; #Greenhouse technology#

UNIT II 18 hours

Cell culture techniques: Single cell culture techniques, Cell suspension culture; Haploid and triploids plant production, Protoplast isolation and culture, Somaclonal variation-somatic hybridization; cybrids. Plant secondary metabolites production, alkaloids, industrial enzymes, #bioplastics#.

UNIT III: 18 hours

Techniques in plant transformation: Gene transfer methods - Vector mediated gene transfer – Agrobacterium mediated gene transfer – crown gall disease and Ti plasmid – Hairy root disease of *A.rhizogenes* (Ri plasmid); Virus mediated gene transfer: Caulimovirus as vector and Geminivirus as vector, RNA plant virus as vector; Direct gene transfer: #Physical and chemical method#.

UNIT IV: 18 hours

Transgenic plants: Herbicide resistance: phosphoinothricin, glyphosate-sulfonyl urea and atrazine. Insect resistance: *Bt* genes, non-*Bt* genes like protease inhibitors, alpha amylase inhibitor. Plant disease resistance: plant pathogen interaction, existing approaches to combating disease, Natural disease resistant pathways. Biotechnological approaches to disease resistant. #Abiotic stress: Drought, cold and salt#. Post-harvest losses: long shelf life of fruits.

UNIT V: 18 hours

Plant biotechnology tools for crop improvement: Molecular markers - Restriction based ; PCR based markers – RFLP, RAPD, AFLP, ISSR, SNP; Development of SCAR and SSR markers; Marker assisted selection and breeding – Selectable markers, reporter genes and promoters used in plant vectors; SAAT and floral dip transformation technique in Arabidopsis; Intellectual Property Right (IPR) and Protection (IPP), IPR and Plant Genetic Resources. #GMO applications in food and agriculture - Cartegena Protocol and food safety– Ethical issues and Resilience of GM crops#.

 # # Self-study portion

Text Books:

1. Kalyankumar De. An Introduction to Plant Tissue Culture Techniques. New Central Book Agency, Kolkata. 2007.
2. Adrian Slater, Nigel W. Scott and Mark R. Fowler., Plant Biotechnology (The genetic manipulation of plants). Oxford University press, UK. 2003.

Books for Reference:

1. Donald Grierson and S.V. Convey.. Plant Molecular Biology. Blackie and Son Limited. New York, 2010.
2. M.J. Chrispeels and D.F. Sadava. Plants, genes and agriculture, The American Scientific Publishers, USA. 2010.
3. S.H. Mantell, and H. Smith. Plant Biotechnology by. Cambridge University press, UK. 2001.
4. Mathews and Mickee. An introduction to genetic engineering in plants, Blackwell Scientific Publishers. London. 2015.
5. R.J. Henry. Practical Application of Plant Molecular Biology. Chapmans and Hall. 2013.

Web Source

1. https://nptel.ac.in/courses/102/103/102103016/
2. https://nptel.ac.in/courses/102/103/102103013/
3. https://swayam.gov.in/nd2_cec19_bt01/preview

Relationship Matrix for Course Outcomes, Programme Outcomes and Programme Specific Outcomes:

Semester	**Code**		**Title of the Paper**			**Hours**				**Credits**
III	**20PBT3CC9**		**PLANT BIOTECHNOLOGY**			**6**				**5**
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓		✓	✓		✓	✓	✓	✓	✓
CO2	✓	✓	✓	✓		✓	✓	✓	✓	✓
CO3	✓	✓	✓	✓		✓	✓	✓	✓	✓
CO4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO5	✓		✓	✓	✓	✓		✓	✓	✓
Number of Matches= 44, Relationship : High										

Prepared by:

1. Dr. J. Sebastin Raj

Checked by:

1. Dr. Y. Arsia Tarnam

Note:

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very poor	Poor	Moderate	High	Very high

Semester	Code	Course	Title of the Course	Hours	Credits	Max. marks	Internal marks	External marks
III	20PBT3CC10	Core – X	ANIMAL BIOTECHNOLOGY	6	5	100	25	75

Course Outcomes

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

1. Expertise the concepts of animal cell culture.
2. Acquire the knowledge of methods used in gene transfer technology in Animal.
3. Ensure students to gain knowledge about IVF and transgenic animals.
4. Enable the students to learn about stem cells, hybridoma technology and gene therapy.
5. Gain knowledge about various types of vaccine production.

UNIT I: 18 hours

Animal Cell Culture-Development and maintenance of cell lines, continuous cell lines, culture Media for cultured cells & tissues - natural & defined media, Preparation of various tissue culture media, components and their function- serum- and serum free media; CO_2 incubator; Expression of culture efficiency, cell death and apoptosis. Organ culture methods of introducing of DNA into cell lines – microinjection- calcium phosphate transfection- lipofection- electroporation; Cell hybridization, hybridoma& monoclonal antibodies production. #Cell synchronization.Preservation of animal cells, American type culture collection (animal cell line)#.

UNIT II: 18 hours

Vectors- Biology and methods for the construction of Animal viral vectors - SV40, adeno virus, retro virus, vaccina virus, herpes virus, adeno associated virus and Baculo virus. Gene transfer in cells; physical, chemical and biological methods. Molecular Pharming for production of medical and diagnostic products- regulatory proteins, #blood products, hormones#.

UNIT III: 18 hours

Animal Biotechnology in Reproduction - Semen storage - Artificial insemination, Super ovulation, Oestrus Synchronization. In vitro culture and maturation of animal oocytes and its storage - Methods of transferring genes into animal oocytes, eggs, embryos and specific tissues - IVF - gamete selection . **Transgenic animals**- Development and use of transgenic animals – retroviral method- embryonic stem cell method- micro –injection method, Cloning of animals - Transgenic livestock production - Transgenic Fish production - #Fish and silkworm as living Bioreactors#.

UNIT IV: 18 hours

Stem cells –Types, preparation and applications of embryonic, adult and umbilical cord blood stem cells. Stem cell differentiation and transplantation. Bioethics and stem cell research.

Hybridoma technology: Monoclonal antibody production, fusion methods, selection and screening methods for positive hybrids. Purification of monoclonal antibodies and its applications.

Gene therapy – types, vectors and sites of gene therapy, *ex-vivo* and *in-vivo* methods.Antisense and ribozyme therapy- Protein Aptamers- Intrabodies.Human Genome Project.

Gene knockout techniques – Strategies of gene delivery -Targeted gene replacement, #Gene correction.Chromosome engineering#.

UNIT V: **18 hours**

Vaccine Production: Active and passive immunization- whole organism vaccines- purified macromolecules as vaccines- recombinant vector vaccines- DNA vaccines- multivalent subunit vaccines strategies for Malaria, Rabies, Hepatitis B, HIV, SARS - Co2 and Cancer; Dendrites cells as therapeutic agents; #Multi- valent vaccines#.

 # # Self-study portion

Text Books:

1. Butterworthh –Heineman. "*In vitro* cultivation of animal cells", 5th Edition, Butterworth Heineman Ltd. 2004.

2. R.W. John Masters., "Animal cell culture", 3rd Edition, Oxford university press. 2004.

Books for Reference:

1. J.R.W.Masters, "Animal Cell culture", Oxford University Press. 2010.
2. M.M.Ranga, "Animal Biotechnology", Student Edition- Jodhpur. 2013.
3. V.Mehta, Animal Biotechnology. Campus Books International, New Delhi, India,2016.
4. S.B.Primrose, R.W. Twyman, Principles of Gene Manipulation and Genomics, Seventh edition, Wiley Blackwell, 2006.

Web Source

1. https://nptel.ac.in/courses/102/104/102104059/

2. https://nptel.ac.in/content/storage2/courses/104108056/module9/PNR%20lecture%2034.pdf

Relationship Matrix for Course Outcomes, Programme Outcomes and Programme Specific Outcomes:

Semester	**Code**			**Title of the Paper**		**Hours**		**Credits**		
III	**20PBT3CC10**			**ANIMAL BIOTECHNOLOGY**		**6**		**5**		
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓	✓	✓		✓	✓	✓	✓	✓
CO2	✓		✓	✓		✓		✓	✓	✓
CO3	✓	✓	✓	✓		✓	✓	✓	✓	✓
CO4	✓		✓	✓	✓	✓		✓	✓	✓
CO5	✓		✓	✓	✓	✓	✓	✓	✓	✓
Number of Matches= 42, Relationship : High										

Prepared by:

1. Dr. T. Nargis Begum

Checked by:

1. Dr. Y. Arsia Tarnam

Note:

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very poor	Poor	Moderate	High	Very high

Semester	Code	Course	Title of the Course	Hours	Credits	Max. marks	Internal marks	External marks
III	20PBT3CC11	Core– XI	MICROBIAL TECHNOLOGY	6	4	100	25	75

Course Outcomes

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

1. Describe the role of bacterial and cell culture in protein product development.
2. Describe how Biotechnological methods are being used to understand and protect the environment.
3. Gain knowledge about the role genetically modified organisms in the environment.
4. Discuss the role of probiotics in human health.
5. Discuss the field of genomics and proteomics methods used for protein study and the potential benefits of proteomic research.

UNIT I: Microbial Technology **18 hours**

Introduction to microbial technology and definition, Applications of microbial technology – pharmacogenomics, pharmaceutical products, genetic testing, gene therapy, improving agricultural yield, cheese production, wine production, production of novel substances, biological engineering, #bioremediation and biodegradation#.

UNIT II: Genetic Engineering of Microorganisms (GEMS) **18 hours**

Process, Genetically modified organisms - transgenic microbes; applications of GEMS, Disease Diagnosis, Disease Treatment; Drug Delivery and Targeting, Degradative (Catabolic) Genes - Chlorobenzoates, #Polychlorinated Biphenyls (PCB) and Chlorobiphenyls, Trichloroethylene (TeE)#.

UNIT III: Integrated Microbial Genomes System **18 hours**

Microbial genome application, Microbial Genome Data Types, Microbial Genome Annotation, Microbial Genome Data Sources, JGI Microbial Genome Data, microbial genome system requirements, Data Content Requirements, Application Requirements, #Microbial Genome Data Analysis#.

UNIT IV: Microbial Biotechnology scope and techniques **18 hours**

Human therapeutics - Production of heterologous proteins, secondary metabolites as a source of drugs; Agriculture - ability to grow in harsh environments, herbicide tolerance, resistance to insect pests; Food Technology - preparation of fermented foods (NIsin, *Lactobacillus Sakei*: a promising biopreservative and monensin); Probiotics, #Environmental applications of microorganisms#**.**

UNIT V: Microbial Genomics and Proteomics **18 hours**

Bacteriophage genomics, Cyanobacteria genomics, Full genome sequencing (FGS), DNA sequencing technology - Shotgun sequencing technology, Nanopore technology, SMRT (single molecule real time), DNA Nanoball (DNB) technology and pyrosequencing; #Strategies of microbial proteomics - Top Down Strategy and Bottom up Strategy#, Applications of microbial genomics and proteomics.

 # # Self-study portion

Text Books:

1. Uma Shankar Singh and Kiran Kapoor, Microbial Biotechnology, Oxford Book Company, 2010.
2. N. Alexander , Glazer and Hiroshi Nikaido, Microbial Biotechnology - Fundamentals of Applied Microbiology, 2nd Edition, Cambridge University Press, 2007.

Books for Reference:

1. Yuan Kun Lee, Microbial Biotechnology: Principles and Applications, World Scientific, 2006.
2. Lee Yuan Kun, Microbial Biotechnology: Principles and Applications, World Scientific, 2003.

Web Source

1. https://nptel.ac.in/courses/102/103/102103013/

2. https://nptel.ac.in/content/storage2/courses/102103013/pdf/mod7.pdf

Relationship Matrix for Course Outcomes, Programme Outcomes and Programme Specific Outcomes:

Semester	**Code**			**Title of the Paper**			**Hours**			**Credits**
III	**20PBT3CC11**			**MICROBIAL TECHNOLOGY**			**6**			**4**
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓		✓	✓		✓	✓	✓	✓	✓
CO2	✓	✓	✓	✓		✓	✓	✓	✓	✓
CO3	✓		✓	✓		✓	✓	✓	✓	✓
CO4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO5	✓	✓	✓	✓	✓	✓		✓	✓	✓
Number of Matches= 44, Relationship : High										

Prepared by:
1. Dr. Y. ArsiaTarnam

Checked by:
1. Dr. J. Sebastin Raj

Note:

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very poor	Poor	Moderate	High	Very high

Semester	Code	Course	Title of the Course	Hours	Credits	Max. marks	Internal marks	External marks
III	20PBT3CC12P	Core – XII	PLANT BIOTECHNOLOGY, ANIMAL BIOTECHNOLOGY, MICROBIAL TECHNOLOGY-PRACTICAL	6	4	100	20	80

Course Outcomes

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

1. Develop the skills of pilot scale production of secondary metabolites.
2. To understand the processes involved in the planning, conduct and execution of Plant and animal biotechnology experiments.
3. To use basic biotechnological techniques to explore molecular biology of plants, animals and microbes.
4. Advanced knowledge of the underlying principles of tissue culture techniques and its application in solving problems in biological systems.
5. Employing the processes include traditional fermentation procedures and also those involving organisms modified by recombinant DNA technology.

List of Practicals:

Plant Biotechnology

1. Organizing plant Tissue culture Laboratory and Preparation of Tissue Culture Media.
2. Propagation of plantlets by direct and indirect organogenesis.
3. Somatic embryogenesis and Artificial seed preparation.
4. Haploid plant production - Anther and Pollen culture.
5. Protoplast isolation and culture by Mechanical and enzymatic methods.
6. Transformation of leaf discs with Agrobacterium.
7. Industrial visit to National Research Center for Banana (NRCB)

Animal Biotechnology

1. Organizing animal cell culture Laboratory
2. Preparation of tissue culture media and sterilization.
3. Primary cell culture and subculture.
4. Isolation of lymphocyte from human blood.
5. Counting of cells using Haemocytometer.
6. Primary culture of Fibroblast culture/embryo culture.

Microbial Technology

1. Preparation of bio inoculants and cell count determination on time scale.
2. Preparation of enzyme immobilized columns for biotransformation –e.g. yeast cells immobilized in calcium alginate beads.
3. Isolation and screening of Enzyme producing microorganisms from soil.
4. Screening and isolation of Antibiotic producing organisms from soil.
5. Alcohol fermentation by Yeast.

Text Books:

1. Kalyankumar De. An Introduction to Plant Tissue Culture Techniques. New Central Book Agency, Kolkata. 2007.
2. R.W.John, Masters. "Animal cell culture", 3rd Edition, Oxford University press. 2004.

Books for Reference:

1. E.M.T.El-Mansi et al. Fermentation microbiology & biotechnology. CRC / Taylor & Francis, 2007.

Web Source

1. **https://www.researchgate.net/publication/306018037_A_Plant_Biotechnology_Laboratory_Manual**
2. **https://www.austincc.edu/awheeler/Files/BIOL%201414%20Fall%202011/BIOL1414_Lab%20Manual_Fall%202011.pdf**
3. **https://microbiologyonline.org/file/7926d7789d8a2f7b2075109f68c3175e.pdf**

Relationship Matrix for Course Outcomes, Programme Outcomes and Programme Specific Outcomes:

Semester	**Code**			**Title of the Paper**				**Hours**		**Credits**
III	**20PBT3CC12**			**PLANT BIOTECHNOLOGY, ANIMAL BIOTECHNOLOGY, MICROBIAL TECHNOLOGY-PRACTICAL**				**6**		**4**
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1		✓	✓	✓	✓		✓	✓	✓	✓
CO2	✓			✓				✓	✓	✓
CO3	✓	✓	✓	✓		✓		✓	✓	✓
CO4	✓	✓	✓			✓	✓	✓	✓	✓
CO5	✓	✓	✓	✓		✓	✓	✓	✓	✓
Number of Matches= 38, Relationship : High										

Prepared by:
1. H.F.SeyedMafiyaHaniff

Checked by:
1. Dr. J. Sebastin Raj

Note:

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very poor	Poor	Moderate	High	Very high

Semester	Code	Course	Title of the Course	Hours	Credits	Max. marks	Internal marks	External marks
III	20PBT3DE3A	DSE – III	STEM CELL BIOLOGY	6	4	100	25	75

Course Outcomes

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

1. Gain an understanding on the basic concepts of stem cells, types and its present and future challenges.
2. Relate the aspects about the natural history of stem cells.
3. Develop an understanding about embryonic stem cells.
4. Discuss the role of stem cells in regenerative medicine.
5. Illustrate on the stem cells for tissue grafts and elucidate the details about stem cells culture.

UNIT I: STEM CELL BASICS **18 hours**

Definition, properties of stem cells – self renewal, clonality, pluripotency, totipotency; Where Do Stem Cells Come From - stem cells of the early embryo, ontogeny of adult stem cells; stem cell niche; Molecular Bases of Pluripotency: signal transduction cascades to the stem cell nucleus - #Oct4 is a key transcription in pluripotency#; Present Perspective and Future Challenges.

UNIT II: EMBRYONIC STEM CELLS **18 hours**

Pluripotent Stem Cells in the Early Embryo, Embryonal Carcinoma Cells, Derivation of Embryonic Stem Cells, Factors Influencing ES Cell Derivation, Embryonic Germ Cells, Genome manipulation in ES cells - Insertional Mutagenesis and Gene Trapping, Targeted Gene Modification, Chromosome Engineering, #Maintenance of ES Cell Pluripotency#.

UNIT III: ADULT STEM CELLS **18 hours**

Somatic stem cells – test for identification of adult stem cells – adult stem cell differentiation – trans differentiation – plasticity – different types of adult stem cells: Hematopoietic stem cells, mesenchymal stem cells, #Bone Marrow Stem Cells, Adipose (fat) Stem Cells#.

UNIT IV: STEM CELLS IN TISSUE ENGINEERING **18 hours**

Reservoirs of postnatal stem cells, current approaches to tissue engineering: ex vivo culture of postnatal stem cells, delivery of stem cells; reconstruction of the skeleton - bone and cartilage, skeletal and cardiac muscle regeneration; ex vivo reconstructions - cells, scaffolds, and bioreactors:#activation of local and distant endogenous stem cells#.

UNIT V: THERAPEUTIC APPLICATION OF STEM CELLS, REGULATION & ETHICS

18 hours

Stem cells in spinal cord injury, heart disease, diabetes, gene therapy; Genome editing of stem cells; Ethics of Human Stem Cell Research; FDA Product and Preclinical Regulatory considerations.Computational stem cell biology, #applications of Bioinformatics Tools in Stem Cell Research#.

 # # Self-study portion

Text Books:

1. Robert Lanz, John Gearhart, Brigid Hogan et al, Essential of stem cell Biology, Elsevier Academic Press, 2006.
2. R. Daniel, Marshak, Richard l. Gardner, David Gottlieb, Stem Cell Biology, Cold spring Harbor Laboratory Press, 2001.

Books for Reference:

1. Paul Knoepfler, Stem Cells: An Insider's Guide. World Scientific. 2013.
2. C.Potten, Stem cells,.Elsevier Publication.1996
3. AmitaSarkar, Embryonic stem cells. Discovery Publishing House Pvt. Ltd. 2009.

Web Source

1. http://jprsolutions.info/newfiles/journal-file-56c675c7d3f8c9.27227172.pdf

Relationship Matrix for Course Outcomes, Programme Outcomes and Programme Specific Outcomes:

Semester	Code			Title of the Paper			Hours			Credits
III	20PBT3DE3A			STEM CELL BIOLOGY			6			4
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓	✓	✓	✓	✓		✓	✓	✓
CO2	✓		✓		✓	✓	✓	✓	✓	✓
CO3	✓				✓	✓		✓	✓	✓
CO4	✓	✓		✓	✓	✓	✓	✓	✓	✓
CO5	✓			✓	✓	✓	✓	✓	✓	✓
Number of Matches= 40, Relationship : High										

Prepared by:
1. Dr. Y. Arsia Tarnam

Checked by:
1. Dr. J. Sebastin Raj

Note:

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very poor	Poor	Moderate	High	Very high

Semester	Code	Course	Title of the Course	Hours	Credits	Max. marks	Internal marks	External marks
III	20PBT3DE3B	DSE – III	MARINE BIOTECHNOLOGY	6	4	100	25	75

Course Outcomes

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

1. Explain principle features of marine ecosystems and the microbial diversity
2. Describe and discuss marine microbes in terms of physiological capability and their biogeochemical role.
3. Acquire the knowledge on natural products of marine origin
4. Discuss the mechanisms associated with marine byproducts.
5. Learn the concept of microbes available in an aquatic environment, their role and interaction with the marine environment.

Unit I: Marine Ecology: 18 hours

Benthic and Pelagic Zone; Photic, dysphotic and aphotic zones- importance and their significance. Biological divisions of the sea- estuaries and backwaters, lagoons, mangroves, coastal waters, inshore, offshore, #deep sea/oceanic zone#.

Unit II: Biological Resources and taxonomy: 18 hours

Sampling, cultivation and taxonomy of organisms.Metagenomics.Flora, Fauna, Bacteria, fungi, algae and archaea.Extremophilic microorganisms; Fisheries and other aquatic potential. Role of marine organisms in carbon, nitrogen, #phosphorus and sulphur cycles#.

Unit III: Marine microbial pathogens and Aquaculture: 18 hours

Microbial pathogens in marine environment - diversity, sources and detection of pathogens in recreational water, impact of harmful algal blooms, microbial pathogens of seafood. Biofloc technology; Aquaponics; Zero water exchange aquaculture system; Aquamimicry; Hydroponics; Raceway system of aquaculture; #Bioremediation in Aquaculture systems#.

Unit IV: Marine Bioprospecting: 18 hours

Marine organisms for Biofuels and bioenergy, Bioremediation, Biofouling, Biosurfactants. Marine natural products as cosmetics-cosmeceuticals, algotherapy; Thalassotherapy; Enzymes; food, supplement, nutrition and energy drinks. Marine algae as fish feed, #manure and fertilizers#.

Unit V: Marine Byproducts: 18 hours

Marine derived drugs in preclinical and clinical trials- FDA and EMEA approved marine derived drugs, their use and mode of action. Screening of drugs High-throughput Screening Assays (HTS). Bioassays- Enzyme assays, cytotoxicity assay; antimicrobial assay;#DNA laddering assay; Apoptosis assays#.

 # # Self-study portion

Text Books:

1. T. Scheper, Le Gal Y, Ulber R, Marine Biotechnology II, Springer, 2005.
2. P. Proksch and W.E.G. Müller (Eds.), Frontiers in Marine Biotechnology [Hardcover], Taylor & Francis; edition, 2006.

Books for Reference:

1. Se-Kwon Kim, Essentials of Marine Biotechnology, Springer Nature, 2019
2. G. Karleskint, R. Turner, and J. Small (Eds.), Introduction to Marine Biology, Brooks Cole; 3rd edition, 2009.

Web Reference:

1. http://archives.esf.org/fileadmin/Public_documents/Publications/marine_biotechnology_01.pdf
2. https://marinebio.org/creatures/

Relationship Matrix for Course Outcomes, Programme Outcomes and Programme Specific Outcomes:

Semester	**Code**			**Title of the Paper**			**Hours**		**Credits**	
III	**20PBT3DE3B**			**MARINE BIOTECHNOLOGY**			**6**		**4**	
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓	✓	✓	✓	✓		✓	✓	✓
CO2	✓		✓	✓		✓	✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO4	✓		✓	✓		✓	✓	✓	✓	✓
CO5	✓		✓	✓		✓		✓	✓	✓
Number of Matches= 44, Relationship : High										

Prepared by:
1. Dr. Y. Arsia Tarnam

Checked by:
1. Dr. J. Sebastin Raj

Note:

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very poor	Poor	Moderate	High	Very high

Semester	Code	Course	Title of the Course	Hours	Credits	Max. marks	Internal marks	External marks
IV	20PBT4CC13	Core – XIII	BIOINFORMATICS AND BIOSTATISTICS	6	5	100	25	75

Course Outcomes

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

1. Identify the scope of Computational Biology and Bioinformatics.
2. Ability to design programs with interactive Input and Output program c.
3. The Study of understanding biological information. Retrieval methods for DNA sequence.
4. Gain the knowledge Major Biological Databases and Information.
5. Determine the category of measures of central tendency, dispersion and correlation for analysis of data.

18 hours

Unit I: Structural Biology: Bioinformatics scope and history, facters determining primary – secondary- tertiary and quaterary structure of proteins - protein information resources- biological databases, primary sequence databases, secondary database. # Composite protein sequence database#.

18 hours

Unit II: Biological Database & DBMS Databases: Open access bibliographic resources and literature databases. Introduction to DBMS - Types of databases. Flat file database - Relational databases - Object oriented databases - Database software: Overview of Sequence Retrieval System – Oracle - MySQL. Database design.#visualization of databases and software#.

18 hours

Unit III: Biological Sequence analysis: Pair wise sequencealinmentcomparison - Scoring matrix, Dynamics programming, – FASTA, and BLAST. Multiple sequence alignments - Phylogenetic alignment- Evolution, Element of Phylogeny Methods.Protein structure visualization tools - #RasMol, Swiss PDB Viewer #Protein indetification programs- Moscot.Protein interaction#.Moeculardociking.

18 hours

Unit IV: ProgrammingIn C & Perl: C-language-Introduction- Type of Operators- variables- input output statements- control statements- function- arrays- pointers- structures- unions- file handling and case studies. Introduction to PERL- variables- strings and numbers- lists conditional loops- strings- pattern matching- #applying PERL to bioinformatics#.

18 hours

Unit V: Biostatistics Analysis : Measures of central Tendency - mean arithmetic's- harmonic and geometric median and mode - measures of dispersion - standard deviation and standard error; correlation coefficient- simple linear regress- #SPSS Packages#.

Biostatiscs Application: Properties of Normal Distributions, Point and Interval Estimates of Means and Proportions: #Hypothesis Tests, One Sample Test- t-Test#.

 # # Self –study portion

Text Books:

1. S.C Rastogi ,N.Mendiratta, P.Rastogi. Bioinformatics Methods and Application Genomics, Proteoics and Drug Discovery, 2004.

2. Mike Mc Grath, Perl in Easy steps, 2005.

3. R.S.N. Pillai and V. Bagavathi.Statistics – Theory and Practice.S. chand and Company Ltd., New Delhi, 2006.

4. Glovery and Mitchell. An Introduction to Biostatistics, 2009.

Books for Reference:

1. S.R. Swindell, R.R.Miller and G.S.A. Myers (Eds.), Internet for the Molecular Biologist, Horizon Scientific Press, Wymondham, UK, 1996.

2. Andrea Cabibbo, Richard Grant and Manuela Helmer-Citterich (Eds.), The Internet for Cell and Molecular Biologists (2nd Edn.), Horizon scientific Press, Norwich, 2004.

Web Source

1. https://www.epictraining.ca/course/15958/biological databases/-distance
2. https://bioinformatics.mit.edu/

Relationship Matrix for Course Outcomes, Programme Outcomes and Programme Specific Outcomes:

Semester	**Code**		**Title of the paper**			**Hours**		**Credits**		
IV	**20PBT4CC13**		**BIOINFORMATICS AND BIOSTATISTICS**			**6**		**5**		
Course Outcomes	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓	✓	✓		✓		✓	✓	✓
CO2	✓		✓	✓	✓	✓			✓	✓
CO3	✓	✓	✓	✓		✓	✓	✓	✓	✓
CO4	✓		✓	✓	✓	✓		✓	✓	✓
CO5	✓	✓	✓	✓		✓		✓	✓	✓
Number of Matches = 44, Relationship : High										

Prepared by:
1. Dr. K. Gobalan

-

Checked by:
1. Dr. T. Nargis Begum

Note:

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very poor	Poor	Moderate	High	Very high

Semester	Code	Course	Title of the Course	Hours	Credits	Max. marks	Internal marks	External marks
IV	20PBT4CC14	Core – XIV	ENVIRONMENTAL BIOTECHNOLOGY	6	5	100	25	75

Course Outcomes

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

1. Understand the global environmental problems.
2. Understand the principles and the applications of the treatment process for wastewater, sewage and solid waste in environmental management.
3. Analyze the environmental significance of biotechnological methods for pollution detection and abatement.
4. Describes the use of value added byproducts of environmental biotechnology
5. Understand the emerging techniques of eco-friendly bio products.

UNIT I: Global Environmental Problems 18 hours

Industrial Pollution and its remedy, Greenhouse effect and global warming, Measures to control greenhouse effect, acid rain, climate change. Depletion of ozone – ozone hole– effect of ozone depletion – Measures to control ozone depletion. depletion of natural resources, deforestation and loss of biodiversity, El Nino-Southern oscillation and La Niña,#sea level rise#.

UNIT II: Treatment processes for wastewater and sewage 18 hours

Waste water and sewage treatment - Aerated lagoons, Activated sludge, Trickling filters and biological tower, rotating biological contactors. Landfill technologies - landfill sites; Composting - composting plant process, aerated pile system, Tunnel composting, rotating drum systems, anaerobic composting; Lagoons - #Aerobic Stabilization Lagoons and Anaerobic Stabilization Lagoons#.

UNIT III: Biotechnological methods for pollution detection and abatement 18 hours

General bioassay in pollution monitoring, DNA-gene probe, Immunoassay, Bioluminescent Lux reporter gene technology, Biosensor in environmental analysis, Photosynthesis as a means of reducing CO_2 emission, biological calcification, biological nitrogen and phosphorus removal from wastewater.Plants in aquatic metal pollution abatement, #Engineering Strategies for Bioremediation - *In Situ* and *Ex Situ* Bioremediation#.

UNIT IV: Emerging techniques in specific pollution problems and eco-friendly bio products

18 hours

Biopulping, biofiltration, novel electrochemical DNA sensor, Biodegradation of polymer - polyethylene and polypropylene, poly (L-lactide), Bioremediation of crude oil spills. Biopesticide, biofertilizer, bio energy and biofuels, biological hydrogen generation, microbial fuel cell (MFC), #biodegradable plastics#.

UNIT V: Value added byproducts of Environmental Biotechnology:

18 hours

Composting, aerobic intensive bioconversion of organic wastes into fertilizer, recovery of metals from - mining, industrial waste, waste stream by sulfate reducing Bacteria, #recovery of phosphate and ammonia by iron reducing and oxidizing Bacteria#.

 # # Self-study portion

Text Books:

1. K. Rajiv, Sinha, Rohit Sinha, Environmental Biotechnology, Aavishkar Publishers, Distributors, 2008.
2. E. John, Smith, Biotechnology, 5TH edition, Cambridge University Press, 2009.
3. E.Bruce, Rittmann, Perry L. McCarty, Environmental Biotechnology: Principles and applications, McGraw-Hill, 2005.
4. A. K. Chatterji, Introduction to Environmental Biotechnology, Prentice-Hall of India Private Limited, 2011.

Books for Reference:

1. M. H. Fulekar, Environmental Biotechnology, CRC Press, 2010.
2. K.C. Agrawal, Environmental Biotechnology, Nidhi Publishers (India), Bikaner. 2004.
3. K. Pradipta, Mohapatra. Environmental Biotechnology, I.K. International Publishing House Pvt. Ltd. 2008.

Web Source

1. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.539.8486&rep=rep1&type=pdf
2. https://www.biotecharticles.com/Bioinformatics-Article/Environmental-Informatics-and-its-Applications-3381.html

Relationship Matrix for Course Outcomes, Programme Outcomes and Programme Specific Outcomes:

Semester	**Code**			**Title of the Paper**				**Hours**		**Credits**
IV	**20PBT4CC14**			**ENVIRONMENTAL BIOTECHNOLOGY**				**6**		**5**
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓		✓	✓		✓		✓	✓	✓
CO2	✓	✓	✓	✓		✓	✓	✓	✓	✓
CO3	✓		✓	✓	✓	✓	✓	✓	✓	✓
CO4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO5	✓		✓	✓		✓		✓	✓	✓
Number of Matches= 42, Relationship : High										

Prepared by:
1. Dr. Y. Arsia Tarnam

Checked by:
1. Dr. J. Sebastin Raj

Note:

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very poor	Poor	Moderate	High	Very high

Semester	Code	Course	Title of the Course	Hours	Credits	Max. marks	Internal marks	External marks
IV	20PBT4CC15P	Core – XV	BIOINFORMATICS AND BIOSTATISTICS, ENVIRONMENTAL BIOTECHNOLOGY - PRACTICAL	6	5	100	20	80

Course Outcomes

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

1. Ability to design programs with interactive Input and Output program c.
2. The Study of understanding biological information. Retrieval methods for DNA sequence.
3. Gain the knowledge in Major Biological Databases and Information.
4. Identify the pollutant degrading organisms from the environment.
5. Describe the steps involved in complete analysis of organic matter, coliform bacteria and bioindicators in wastewater.

List of Practicals:

I. Bioinformatics / how to identify ORF /DESIGN PRIMERS

1. Study of Internet resources in Bioinformatics- Eg. NCBI, EMBL.
2. Sequence Alignment by BLAST.
3. Homology modeling of a given protein sequence using SPDBV.
4. Phylogenetic analysis using web tools.
5. Pair wise sequence Alignment.
6. Multiple alignment-CLUSTALW
7. Program to find the percentage of G and C in a DNA sequence.
8. Program to find the percentage of type of amino acid in a sequence.
9. Program to convert DNA to RNA.
10. Program to concatenate DNA fragment.

II. Environmental Biotechnology

1. Estimation of Dissolved Oxygen in water
2. Determination of Total hardness in water
3. Isolation of pollutant degrading microorganisms from the environment.
4. Estimation of concentration of organic matter from wastewater - BOD
5. Estimation of COD in wastewater
6. Indicators of bio pollutants - MPN method
7. Prepare charts for Bio-indicators

Text Books:

1. E. Balagurusamy, Object Oriented Programming with C++" — TMH-2000.
2. Monica D'Souza & Jude D'Souza "Web Publishing" — TMH– 2001.

Books for Reference:

1. Robert Lafore., Object Oriented Programming in C++ - Galgotia.2000.
2. YeshwantKanetkar., let us C++ -– BPB. 2001
3. Steve Wright., Instant HTML Programmer's Reference — WROX Press Ltd.2011.

Web Source

1. https://ocw.mit.edu/courses/computer program /7-06- -spring-2007.
2. https://ocw.mit.edu/courses/biology/7-06-computer application-spring-2010/
3. www.edx.org/learn/Evinormentalbiotechnology

Relationship Matrix for Course Outcomes, Programme Outcomes and Programme Specific Outcomes:

Semester	**Code**		**Title of the paper**			**Hours**			**Credits**	
IV	**20PBT4CC15P**		**BIOINFORMATICS AND BIOSTATISTICS, ENVIRONMENTAL BIOTECHNOLOGY - PRACTICAL**			**6**			**5**	
Course Outcomes	Programme Outcomes (Pos)					Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓	✓	✓		✓		✓	✓	✓
CO2	✓	✓	✓	✓		✓			✓	✓
CO3	✓		✓	✓	✓	✓	✓	✓	✓	✓
CO4	✓	✓	✓			✓			✓	✓
CO5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Number of Matches = 44, Relationship : High										

Prepared by:
1. Dr. K.Gobalan

Checked by:
1. Dr. T. Nargis Begum.

Note:

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very poor	Poor	Moderate	High	Very high

*****