VIJAYANAGARA SRI KRISHNADEVARAYA UNIVERSITY

JNANASAGARA CAMPUS, BALLARI-583105

DEPARTMENT OF STUDIES IN BIOTECHNOLOGY

SYLLABUS

MASTER OF SCIENCE

(I-IV Semester)

With effect from

2021-22

Chairman
BOS in Biotechonology (PG)/UG
Department of P.G. Studies and
Research in Biotechonology
Vijayanagara Sri Krishnadevaraya

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VIJAYANAGARA SRI KRISHNADEVARAYA UNIVERSITY

JNANASAGARA CAMPUS, BALLARI-583105

Department of Studies in

BIOTECHNOLOGY

SYLLABUS

Master of Science

(IV Semester)

With effect from

2022-23

IV-SEMESTER

Semester	Category	Subject code	Title of the Paper	Marks			Teaching hours/week			Credit	Duration of exams (Hrs.)
				IA	Sem. Exam	Total	L	T	P		
FOURTH	DSC11	21BTH4C11L	Plant Biotechnology	30	70	100	4	-	-	4	3
	DSC12	21BTH4C12L	Animal Biotechnology	30	70	100	4	-	-	4	3
	DSE3	21BTH4E3AL	A: Biosafety, Bioethics and IPR	30	70	100	4	-	-	4	3
		21BTH4E3BL	B: Environmental Bioengineering								
		21BTH4E3CL	C: Enzyme Technology								
	DSE4	21BTH4E4AL	A: Nanobiotechnology	30	70	100	4	-	-	4	3
		21BTH4E4BL	B: Proteomics and Protein Engineering								
		21BTH4E4CL	C: Cell signaling								
	GEC2	21BTH4G2AL	A: Introduction to Green engineering and Environmental issues	20	30	50	2	-	-	2	1
		21BTH4G2BL	B: Biology of Immune system								
		21BTH4G2CL	C: Biotechnology for Human Welfare								
	DSC11P9	21BTH4C11P	Plant and Animal Biotechnology lab	20	30	50	-	-	4	2	4
	Project	21BTH4C1R	Research Project	30	70	100	-	-	8	4	4
Total Marks for IV Semester						**600**				**24**	

(I-IV semester)- Total Marks: 2400 Total credits: 96

Dept Name: Biotechnology

Semester-IV
DSC11: Plant Biotechnology

Course Title: **Plant Biotechnology**	Course code: **21BTH4C11L**
Total Contact Hours: (L-T-P): **4 - 0 – 0**	Course Credits: **04**
Formative Assessment Marks: **30**	Duration of ESA/Exam: **03 Hrs**
Summative Assessment Marks: **70**	

Course Outcomes (CO's):

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

1. Acquire the concept of plant tissue culture and its applications.
2. Optimize and formulate media and design plant tissue culture techniques to conduct research.
3. Acquire the knowledge of gene transfer techniques in plants.
4. Asses the transgenic plants using various molecular markers.
5. Apply the concepts of recombinant DNA techniques in developing transgenic plants.

DSC11: Plant Biotechnology

Unit	Description	Hours
1	**Introduction:** Introduction and historical developments and applications of Plant tissue and cell culture. Laboratory Design and Developments. Instrumentation. Sterilization techniques, Plant Tissue Culture Media, Cellular totipotency, Factors affecting Tissue Culture success: (Media explant, light, Temperature, Polarity, Subculture, Genotype, Season), Hormones.	11
2	**Plant Tissue and cell culture:** Micropropagation, organ culture, Establishing callus and cell culture, Dynamics of callus growth, callus subculture and maintenance, organogenesis. Embryogenesis, variant selection, Somaclonal variation, cell suspension culture, Somatic embryogenesis in plant. Protoplast isolation and culture. Acclimatization of micro propagated plant. Primary and secondary metabolic products (Phytochemicals) of plant cells, Biosynthesis of secondary metabolites of biotechnological importance.	11
3	**Genetic Engineering in Plants:** Structure and organization of plant genome, regulation of plant genome expression, transcriptional, translational regulation of plant genome. Transposons, Transfer of DNA to plant cells- 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 herbicide, pesticide, plant	11

	pathogens.	
4	**Methods in Plant Biotechnology:** Amplification of DNAs by Polymerase Chain Reaction (PCR). Gene transfer technology Vectors, Gene transfer using Particles Bombardment, Microinjection method, Marker assisted selection (RAPD, RFLP, AFLP, SNP`s etc.). Methods for crop improvement.	**11**
5	**Application of Plant Biotechnology:** Herbicide resistance, disease resistance, novel proteins, vaccines, antibodies and antigens. Immobilized cell systems and Biotransformation. Plant Genome Project: Rice genome project. Hairy root culture and its importance.	**11**

References:

1. Singh BD (2014) Biotechnology- Expanding Horizons. Kalyani Publishers, Rajindernagar, Ludhiana.
2. Reinert J and Bajaj YPS (2013) Applied and Fundamental aspects of Plant Cell, Tissue and organ Culture. Springer Verlag, Berlin.
3. Narayanaswamy S (2008) Plant Cell and Tissue Culture. Tata McGraw Hill, New Delhi.
4. Sathyanarayana B. N. and Varghese, D.B. (2007) Plant Tissue Culture: Practices and New Experimental Protocols. I. K. International Pvt Ltd.
5. Bengochea T and Doods JH (2012) Plant Protoplasts: A Biotechnological Tool for Plant Improvement. Chapman and Hall. London.
6. Gamborg OL and GC Phillips (2013) Plant Cell, Tissue and organ culture. Narosa Publishing House, New Delhi.
7. Razdan MK (2003) An Introduction to Plant Tissue Culture, Oxfsord & IBH Pub. Co, Pvt., Ltd., New Delhi
8. Bhojwani SS and Razdan MK (2003) Plant Tissue Culture: Theory and Practice, a revised edition. Elsevier Publication.
9. Dodds JH and Roberts LW (1995) Experiments in plant Tissue Culture. Cambridge University Press, Cambridge.

Date Course Coordinator Subject Committee Chairperson

Dept Name: Biotechnology
Semester-IV
DSC12: Animal Biotechnology

Course Title: **Animal Biotechnology**	Course code: **21BTH4C12L**
Total Contact Hours: (L-T-P): **4 - 0 – 0**	Course Credits: **04**
Formative Assessment Marks: **30**	Duration of ESA/Exam: **03 Hrs**
Summative Assessment Marks: **70**	

Course Outcomes (CO's):

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

1. Understand the principles of various cell culture techniques and hybridoma technology.
2. Apply advanced techniques in the field of cell culture research and development.
1. Impart knowledge on artificial breeding, production and applications of transgenic animals.
2. Impart knowledge on isolate and culture of stem cells and their application in biomedical field.
3. Apply the concepts of cell culture techniques in the field of modern life science.

DSC12: Animal Biotechnology

Unit	Description	Hours
1	**Animal Tissue culture and Hybridoma Technology:** Cell culture media and preparations. Cell culture techniques: Monolayer and suspension culture, cell lines, organ culture-techniques, three-dimensional culture. Somatic cell fusion and its applications (cybrids, membrane fluid mobility and hybridoma technology). Cryopreservation and storage of animal cells. Primary and immortalized cells, Cell transformation and malignancy.	11
2	**Advanced cell culture techniques and application of cultured cells:** Microscopic techniques: light, electron microscopic, fluorescent and phase contrast microscopic studies. cell culture and viability, Cell Synchronization and cell cycle Analysis (mitotic and flow cytometry). Gene transformation: Transfection, electroporation and liposome). Immuno-techniques IFA (membrane, cytoplasmic and nuclear proteins) Detection of contamination in cell culture.	11
3	**Artificial animal Breeding and Transgenic Technology:** Artificial insemination, Transplantation, in vitro fertilization and embryo transfer, Advantages of cell manipulation, Nuclear transplantation and cell cloning, selective animal breeding and their potential. Production and uses of transgenic animals. Animals as a bioreactor for production various	11

	chemicals. Application of functional genomics and discovery of new genes, animal welfare and human health	
4	**Stem cells and its application:** Source and isolation of stem cells, Embryonic and adult stem cells, culture and maintenance of stem cells. Generation and manipulation of mouse and human embryonic stem cells. Germ Cell Development: Epigenesis and Reprogramming of adult-stem cells. Molecular mechanisms of self-renewal and differentiation, pluri/multi potency and lineage differentiation. Bone transplant and reconstitution of hematopoietic system. Stem cells and therapeutics. Novel sources of multipotent stem cells. Science policies and Ethics in Stem Cell Research	**11**
5	**Applications of Animal Biotechnology:** Animal improvement: diary, fishery and poultry). Medicine: diagnosis of diseases, detection of genetic disorders. Treatment: vaccines, gene and cell therapy, tissue transplantations. Production of pharmaceutical chemicals, interferons, interleukins, stem cell factors and hormones. Industrial applications: metabolites production, bio control agents, industrially important enzymes. Drug testing and evaluation.	**11**

References:

1. Freshney RI (2005) Culture of Animal Cells, 5th Edn, Wiley-Liss.
2. Spier RE and Griffiths JB (1988) Animal Cell Biotechnology, Academic Press.
3. Clynes (1998) Animal Cell Culture Techniques, 1st Edn, Springer
4. Channarayappa (2006) Molecular Biotechnology: Principles and Practices. University Press (India) Pvt. Ltd., Worldwide CRC Press.
5. Channarayappa (2010) Cell Biology: Universities Press (India) Pvt Ltd.
6. John RW, Masters, (2000) Animal Cell Culture: Practical Approach, 3rdEdn, Oxford.
7. Murray Moo-Young (1989) Animal Biotechnology, Pergamon Press, Oxford.
8. Doyle A, Hay R, and Kirsop BE (1990) Living Resources for Biotechnology, Animal cells, Cambridge University Press

Date Course Coordinator Subject Committee Chairperson

Dept Name: Biotechnology
Semester-IV
DSE3: A: Biosafety, Bioethics and IPR

Course Title: **Biosafety, Bioethics and IPR**	Course code: **21BTH4E3AL**
Total Contact Hours: (L-T-P): **4 - 0 – 0**	Course Credits: **04**
Formative Assessment Marks: **30**	Duration of ESA/Exam: **03 Hrs.**
Summative Assessment Marks: **70**	

Course Outcomes (CO's):

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

1. Capable of understanding biosafety practices.
2. Aware of the ethical issues relevant to Biotechnology.
3. Conversant with biosafety regulations.
4. Have thorough understanding of intellectual property rights.
5. Conversant with procedures used to protect intellectual property rights.

DSE3: A: Biosafety, Bioethics and IPR

Unit	Description	Hours
1	**Introduction to Bioethics and Biosafety:** definition and needs of Bioethics, Social and Ethical issues in biotechnology. Application of bioethics: the expanding scope of ethics from biomedical practice to biotechnology. Introduction to Biosafety: definition and needs of biosafety, levels of biosafety, applications of biosafety at workplace, Biosafety during development of biotech products. Examples and case studies.	10
2	**Ethical Issues:** Ethical issues regarding genetically modified organisms (foods and crops); bioethics in biodiversity and resource management. Animal cloning and human cloning and their ethical aspects. Testing of drugs on human volunteers, organ transplantation and ethical issues; Xenotransplantion and its ethical and social issues. Human Genome project.	11
3	**Biosafety regulations in transgenic research:** National and international guidelines on rDNA technology. MOEF guidelines, Good laboratory practice, Good manufacturing practice and FDA regulations, Regulations for recombinant DNA research and manufacturing process, Public perception. National Institute of health (NIH) guidelines, guidelines for research in transgenic organisms.	11
4	**Introduction to IPR:** IP definition and needs, GATT & WTO, Different forms of IPR – Copyrights, Trademarks, Industrial designs, Geographical Indications, Traditional Knowledge, Plant varieties, Trade Secrets. WIPO, TRIPS, Role of IPR in Research and	12

	Development. **Trademarks and copyrights:** nature of trademarks and branding, tips on names for trademarks, acquiring trademarks protection, brand valuation, packaging and selling, increase the value of a technology through the use of trademark. Introduction and characteristics of copyrights and neighboring rights, performers and broadcasting organizations rights, transfer of copyrights.	
5	**Patents:** Introduction of Patents, patent as an intellectual property, Brief history of patents-Indian and global scenario, types of patents, patent life cycle, criteria for patenting, novelty, inventiveness, utility, patentable subject matter, inventions that are not patentable, term of patent, maintenance of a patent, granted patents Vs. patent publications. **Ideas:** Generation and review of ideas, documenting ideas, literature scanning for possibility of IP rights, decision to go for IP protection or not, and consideration of choice of IP protection, disclosure, inventors' interview, Process and Product Patents.	**11**

References:

1. Sateesh M.K (2008) Bioethics & Biosafety, IK Publishers.
2. Traynor PL (2000) Biosafety Management, Virginia Polytechnic Institute Publication.
3. Acharya N K (2007), Textbook on Intellectual Property Rights, 4th Edn, Asia Law house.
4. Sasson A (1993) Biotechnologies in developing countries present and future, UNESCO Publishers.
5. Rao MB (2003) WTO and International Trade, Vikas Publishing House Pvt. Ltd.
6. Erbisch FH and Maredia KM (2003) Intellectual Property Rights in Agricultural Biotechnology, Orient Longman Ltd.
7. Deborah E Bouchoux (2005) Intellectual Property Rights, Delmar Cengage learning Thomas T Gordon and Arthur S Cookfair (1995), Patent Fundamentals for Scientists and Engineers, CRC Press.

Date Course Coordinator Subject Committee Chairperson

Dept Name: Biotechnology
Semester-IV
DSE3: B: Environmental Bioengineering

Course Title: **Environmental Bioengineering**	Course code: **21BTH4E3BL**
Total Contact Hours: (L-T-P): **4 - 0 – 0**	Course Credits: **04**
Formative Assessment Marks: **30**	Duration of ESA/Exam: **03 Hrs.**
Summative Assessment Marks: **70**	

Course Outcomes (CO's):

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

1. Understand the source and mechanism of environmental pollution
2. Understand the role of microbes and plants in remediation and management of environmental pollution
3. Understand the replacement/options available for non-degradable pollutants

DSE3: B: Environmental Bioengineering

Unit	Description	Hours
1	**Introduction:** Water, Soil and Air: their sources and effects. Major pollutants and their effects on flora and fauna, Removal of Specific Pollutants, concepts of bioaugmentation, biostimulation, biodegradation, biosorption and biofilms in the bioremediation of pollutants, Sources of Heavy metal pollution, microbial systems for heavy metal accumulation, biosorption & detoxification mechanisms. In-situ and ex-situ bioremediation strategies	10
2	**Waste water treatment:** Primary, secondary and tertiary treatment of waste water, biological treatment of anaerobic and aerobic; biochemistry and microbiology of aerobic and anaerobic treatment, use of genetically engineered organisms. Emerging biotechnological processes in waste - water treatment, Bioremediation of contaminated ground water; Membrane technology in waste water treatment, Bioreactors for waste water treatment, treatment of typical industrial effluents: dairy, distillery, dye, and pharmaceutical industries	11
3	**Solid waste treatment**: characteristics of municipal, industrial and biomedical wastes; Aerobic and anaerobic methods, Physical and chemical treatment of solid waste, Composting and vermin-composting. Use of bacteria, fungi, plants, enzymes, an GE organism; Bioremediation of contaminated soils and waste land. Phytoremediation of soil metals; Treatment for waste water from dairy, distillery, tannery, sugar and antibiotic industries	11
4	**Xenobiotic compounds:** aliphatic, aromatics, polyaromatic hydrocarbons, polycyclic aromatic compounds, pesticides, surfactants and microbial treatment of oil pollution. Basic	12

	organic reaction mechanism - common prejudices against enzymes - advantages & disadvantages of biocatalysts - isolated enzymes versus whole cell systems.- mechanistic aspects and enzyme sources.- biocatalytic application, kinetics, and thermodynamics of microbial processes for the transformation of environmental contaminants. Use of solar radiation in industrial effluent treatment; solar detoxification process; environment friendly technologies: biosurfactants, biofertilizers, biopesticides, microbial enhanced oil recovery, resource management, integrated waste management; production of biogas and biofuel from waste.	
5	**Bio-absorption and Bioleaching of heavy metals:** Cadmium, Lead, Mercury, Metal binding targets and organisms, Bioabsorption, Metal microbial interaction, Biomethylation of elements (Methylation of mercury and arsenic), Commercial biosorbants, bioleaching, metal precipitation, advantages and disadvantages of bioleaching.	**11**

References:

1. Pradipta Kumar Mohapatra,"Environmental Biotechnology", I.K. International Publishing House; 1st Ed. Edition,2007.
2. Satyanarayana, U, "A Textbook of Biotechnology", Books and Allied (p) Limited, 2013.
3. Purohit S.S. "Agricultural Biotechnology", 3rd edition, Agrobios, 2010
4. Alan Scragg,"Environmental Biotechnology", Oxford; Second edition, 2007.
5. Hans-Joachim Jordening and Jesef Winter, "Environmental Biotechnology –Concepts and Applications",Wiley VCH, 2004.
6. Metcalf and Eddy, "Waste Water Engineering", 4th edition, Tata McGraw hill,2003
7. Alicia L. Ragout De Spencer, JohnF.T. Spencer."Environmental Microbiology: Methods and Protocols", Humana Press, 2004.
8. Milton Wainwright, "AnIntroduction to Environmental Biotechnology", Springer, 1999

Date Course Coordinator Subject Committee Chairperson

Dept Name: Biotechnology
Semester-IV
DSE3: C: Enzyme Technology

Course Title: **Enzyme Technology**	Course code: **21BTH4E3CL**
Total Contact Hours: (L-T-P): **4 - 0 – 0**	Course Credits: **04**
Formative Assessment Marks: **30**	Duration of ESA/Exam: **03 Hrs.**
Summative Assessment Marks: **70**	

Course Outcomes (CO's):

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

1. Understand the enzymology principles including fundamental properties of enzymes, enzyme catalytic mechanisms and enzyme kinetics.
2. Understand the applications of enzyme technology in food, medical, and household industries.

DSE3: C: Enzyme Technology

Unit	Description	Hours
1	**Introduction:** Properties of enzymes as catalytic power, specificity cofactors, brief nomenclature & classification of enzymes, isoenzymes, Monomeric and oligomeric enzymes, Enzyme localization, Enzyme assay, Direct and coupled assays. Review of uni-substrate enzyme kinetics and factors affecting the rate of enzymes catalyzed reactions.	10
2	**Enzyme kinetics:** Derivation of Michaelis Menten equation using steady state and equilibrium assumptions. Enzyme constants. Transformation of Michaelis – Menten plot to linear forms. Lineweaver-Burk plot, Eadie-Hofstee plots, Hanes plots, Eisenthal and Cornish-Bowden plot. Merits and demerits of linear plots. Haldane relationship for reversible reactions. King and Altman procedure for derivation of rate equation. Michaelis pH functions and their significance	11
3	**Classification of multi substrate reactions:** Ping-pong bi-bi mechanism, Random order mechanism, compulsory order mechanism, Kinetics of multi substrate reactions. General rate equation of Alberty. Derivation of rate expression for ping-pong & ordered Bi -Bi reaction mechanism. Primary and secondary plots for determination of kinetic constants for Multisubstrate reactions. Investigation of reaction mechanism using steady state methods. Use of initial velocity, inhibition and exchange studies to differentiate between multi substrate reaction mechanism. Methods of examining enzymes-complex's, trapping E-S Complex, Use of substrate analogs, chemical modifications and protease treatment, Site directed mutagenesis & effect of changing pH. Flexibility & conformational mobility of enzymes	12

4	Determination of rate constant for enzymes catalyzed reactions, Protein –Ligand binding including measurement, analysis of binding isotherm. Cooperatively phenomenon. Hill and Scatchard plots Allosteric enzymes, sigmodial kinetics and their physiological significance. Symmetric and sequential modes for action of allosteric enzymes and their significance	**11**
5	**Multi enzyme system:** Occurrence, isolation and properties. Polygenic nature of multi enzyme system. Mechanism of catalysis of serine proteases, Ribonucleases and Triose phosphate isomerase. Enzyme regulation: general mechanism of catalysis viz Acid-base, electrostatic, Covalent and enzymes Immobilized enzymes and their industrial application. Effects of partition on kinetics and performance with special emphasis on changes in pH and hydrophobicity.	**11**

References:

1. Enzyme Biochemistry, Biotechnology and Clinical Chemistry. Palmer T., Harwood Pub., 2001
2. Enzyme Technology. Chaplin M.F. &Bucke C., Cambridge Univ. Press, 1990
3. Fundamentals of Enzymology. Price, N.C. & Stevens, L., Oxford Pub., 1999
4. Immobilized Enzymes and Cells. A. Rosevear et al., IOP Pub., 1987
5. Industrial Enzymes and their Applications. Uhlig H. John Wiley and sons, 1998
6. Thermostability of Enzymes. Gupta M.N., Narosa Pub., 1993

Date Course Coordinator Subject Committee Chairperson

Dept Name: Biotechnology
Semester-IV
DSE4: A: Nanobiotechnology

Course Title: **Nanobiotechnology**	Course code: **21BTH4E4AL**
Total Contact Hours: (L-T-P): **4- 0 - 0**	Course Credits: **04**
Formative Assessment Marks: **30**	Duration of ESA/Exam: **03 Hrs.**
Summative Assessment Marks: **70**	

Course Outcomes (CO's):

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

1. Develop an understanding of the fundamental concepts in nanotechnology and different classes of nano-materials.
2. Impart basic knowledge on various synthesis techniques involved in Nanotechnology and characterization.
3. Describe applications of various techniques used in characterization of nanomaterials.
4. Think of novel, future applications of nanotechnology in biotechnology and for molecular medicine.
5. Have knowledge in Applications of Nano-Drug Delivery, Diagnostics and Nanotherapeutics.

DSE4: A: Nanobiotechnology

Unit	Description	Hours
1	**Introduction to Nanotechnology and Nanobiotechnology:** History and scope of nano technology; role of size in nanomaterials: Properties of nano materials- Physical & Chemical properties. Classification of nano particles- nano-clusters, nanotubes, nanowires and nanodots. Electronic structure: quantum dots, quantum wires and quantum wells, confinement of electrons energy quantization, Semiconductor nanocrystals, carbon nanotubes, quantum wells.	**10**
2	**Synthesis of Nanomaterials:** Chemical Method: Chemical precipitation and coprecipitation; Metal nanocrystals by reduction, Sol-gel synthesis; Microemulsions or reverse micelles, myle formation; Solvothermal synthesis; Thermolysis routes, Microwave heating synthesis; Sonochemical synthesis; Electrochemical synthesis; Photochemical synthesis, Synthesis in supercritical fluids. Physical Methods: Vapor deposition and different types of epitaxial growth techniques- pulsed laser deposition - Magnetron sputtering - Micro lithography (photolithography, soft lithography, micromachining, e-beam writing, and scanning probe patterning). Biological Methods: Microbial production of inorganic nanoparticles – Magnetosomes. DNA based nanostructures	**11**
3	**Characterization of Nanomaterials:** Structural Characterization: X-ray diffraction, Small angle X-ray Scattering, Optical Microscope and their description, Scanning Electron Microscopy (SEM), Scanning Probe Microscopy (SPM), Scanning Tunneling Microscopy (STM), Atomic force Microscopy (AFM). Spectroscopic characterizations: application of	**12**

	UV-VIS-IR Raman spectroscopy for analysis of nanomaterials, Surface Characterization: X-ray Photoelectron Spectroscopy (XPS), Auger electron spectroscopy, Low Energy Ion, Scattering Spectroscopy (LEISS), Secondary Ion Mass Spectroscopy (SIMS), Rutherford Backscattering Spectroscopy (RBS). Resonance Methods: Electron Spin Resonance (ESR), Ferromagnetic Resonance (FMR), Nuclear Magnetic Resonance (NMR), Mossbauer Spectroscopy.	
4	**Biological Nanomaterials:** Protein based nanostructures building blocks and templates – Proteins as transducers and amplifiers of biomolecular recognition events – Nanobioelectronic devices and polymer nanocontainers. DNA based nanostructures – Topographic and Electrostatic properties of DNA and proteins – Hybrid conjugates of gold nanoparticles – DNA oligomers – Use of DNA molecules in nanomechanics and Computing. Nano diamonds. Biocompatable polymers: liposomes, dendrimers, chitosan	**11**
5	**Biological Application of Nanotechnology:** Nanoparticles in Therapeutic applications– Drug delivery, imaging and cancer treatment, bone substitutes and dentistry, Implants and Prosthesis, Reconstructive Intervention and Surgery, Nanorobotics in Surgery, Photodynamic Therapy, Neuro-electronic Interfaces, Protein Engineering. Nanotechnology in Agriculture and Food Technology, Biosensors: Principles- DNA based biosensors – Protein based biosensors, Nanosensors in Diagnosis. DNA Templated Electronics, Sequence –specific molecular lithography, Single Biomolecule. Manipulation for Bioelectronics, DNA as a semiconductor. Environmental issues, toxicity of nanomaterials., ethical issues, the future of nanotechnology in medicine.	**11**

References:

1. Edelstein A.S, Cammaratra R.C (1996) Nanomaterials: Synthesis, Properties and Applications, Second Edition, CRC PressTaylor and Francis group New York USA
2. Christof M. Niemeyer, Chad A. Mirkin (2004) Nanobiotechnology: Concepts, Applications and Perspectives John Wiley & Sons
3. Yubing Xie (2012) The Nanobiotechnology Handbook CRC Press Taylor and Francis group New York USA.
4. Richard Booker and Earl Boysen (2005) Nanotechnology, Wiley Dreamtech.
5. Chapman & Hall (2002) Nanobiotechnology–Basic Science & Emerging Technologies, CRC Press.
6. Eric K Drexler, Pelerson C, Pergamit G (1993) Unbounding the future. William Marrow and Company
7. Mark Ratner and Daniel Ratner (2005) Nanotechnology. Prentice Hall
8. Murthy DVS (1995) Transducers and instrtumentation. Prentice Hall of India

Date Course Coordinator Subject Committee Chairperson

Dept Name: Biotechnology
Semester-IV
DSE4: B: Proteomics and Protein Engineering

Course Title: **Proteomics and Protein Engineering**	Course code: **21BTH4E4BL**
Total Contact Hours: (L-T-P): **4- 0 - 0**	Course Credits: **04**
Formative Assessment Marks: **30**	Duration of ESA/Exam: **03 Hrs.**
Summative Assessment Marks: **70**	

Course Outcomes (CO's):

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

1. Enables understanding and exploring protein characteristics that lay foundation to protein engineering studies.
2. Acquire knowledge of protein folding mechanisms and familiarize with bioanalytical techniques.
3. Provide an advanced understanding of the core principles and applications of various important techniques employed for protein structure conformation studies.
4. Facilitate to carry out various in-silico studies to build protein models and study protein ligand interactions that aid in drug design

DSE4: B: Proteomics and Protein Engineering

Unit	Description	Hours
1	**Protein structural families:** basic structural principles: amino acids and their conformational accessibilities, Amino acids: chemical properties, active site residues, Dihedral angles propensity in the proteins, Ramachandran plot, Motifs of protein structures and their packing; schematic and topology diagrams Families of protein structures: alpha, alpha/beta, beta, small, etc, Protein structure on the world wide web: different databases and their uses-PDB, SCOP, CATH 3, DNA binding proteins	11
2	**Protein folding and assembly:** Protein folding pathways in prokaryotes and eukaryotes, Single and multiple folding pathways, Protein denaturation, renaturation of single domain and multi-domain proteins, Inclusion bodies and recovery of active proteins, Osmolyte assisted protein folding, Structure of chaperones and role of chaperones in protein folding, Applications of bio-analytical techniques to study proteins-UV-visible-Flourimetry-HPLC-LC-MS & CD	11
3	**Protein engineering:** Strategies for protein engineering, Random and site-directed mutagenesis, Mutagenesis using various PCR based strategies, Role of low-fidelity enzymes in protein engineering, Gene shuffling and directed evolution of proteins, Protein backbone changes, antibody engineering, Applications of NMR, X-Ray diffraction & Cryo-EM to study protein conformations	11
4	**Prediction and design of protein structures:** Similar structure and function of homologous proteins, Multiple structural alignment, Homology method for protein structure prediction,Ab-initio method for protein structure prediction, Ligand design and protein	11

	docking, Structure based drug design and case studies, Rational protein design, Phage display systems	
5	**Methods for proteomics analysis:** Protein sequencing, Protein expression analysis by 2-DE, 2D-MALDI- TOF MS, LC-MS/MS, Quantitative proteomics. Tandem Mass spectrometry, peptide mass fingerprinting. Mining the proteome, Protein expression profiling, Protein tags; protein arrays and antibody arrays.	**11**

References:

1. Introduction to protein structure, Garland Press. Carl Branden and John Tooze,
2. Structure and mechanism in protein science. Alan Fersht, Freeman
3. Protein engineering in industrial biotechnology, Academic Publishers. Ed. Lilia Alberghina, Harwood
4. Understanding Enzymes. T. Palmer, Prentice Hall
5. Modelling Biological Systems, Springer. Haefner

Date Course Coordinator Subject Committee Chairperson

Dept Name: Biotechnology
Semester-IV
DSE4: C: Cell signalling

Course Title: **Cell signalling**	Course code: **21BTH4E4CL**
Total Contact Hours: (L-T-P): **4- 0 - 0**	Course Credits: **04**
Formative Assessment Marks: **30**	Duration of ESA/Exam: **03 Hrs.**
Summative Assessment Marks: **70**	

Course Outcomes (CO's):

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

1. Understand the mechanism of cell communication.
2. Understand how cells are programmed and the mechanism of cancer and apoptosis.

DSE4: C: Cell signalling

Unit	Description	Hours
1	**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.	11
2	**Cell signaling:** Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways, bacterial and plant two component signaling systems, bacterial chemotaxis and quorum sensing.	11
3	**Cellular communication:** Regulation of hematopoiesis, general principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extra cellular matrix, integrins, neurotransmission and its regulation.	11
4	**Cancer:** Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancer, metastasis, interaction of cancer cells with normal cells, apoptosis, therapeutic interventions of uncontrolled cell growth.	11
5	**Programmed cell death:** Apoptosis - genes involved, Functions: Cell termination - Homeostasis - lymphocyte interaction. Process of Apoptosis: mitochondrial regulation - direct signal transduction - excretion and removal of dead cells. Theories of aging and senescence - gene regulation. Cellular senescence and whole organism aging.	11

References:

1. Michel Friedman and Brett Friedman. 2004. Cell communication: Understanding how information is stored and used in cells. Ingram International Inc.
2. Geoffery M Cooper and Robert E Hausman. 2009. The Cell and Molecular Approach. (Ed: 5). ASM Press and Sinauer Associates Inc.
3. Gomperts, Basten D, Ijbrand M Kramer and Peter ER Tatham. 2009. Signal transduction. (Ed:2).

Academic Press.
4. Ernst JM Helmreich. 2001. The Biochemistry of cell signaling. Oxford Univ Press.
5. Krauss G. 2003. Biochemistry of signaling transduction and regulation. (Ed:3). JohnWiley and Sons.

Date Course Coordinator Subject Committee Chairperson

Dept Name: Biotechnology
Semester-IV
GEC2: A. Introduction to Green engineering and Environmental issues

Course Title: **Introduction to Green engineering and Environmental issues**	Course code: **21BTH4G2AL**
Total Contact Hours: (L-T-P): **2- 0 - 0**	Course Credits: **02**
Formative Assessment Marks: **20**	Duration of ESA/Exam: **1 Hr.**
Summative Assessment Marks: **30**	

Course Outcomes (CO's):

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

1. Apply the scientific method, and recognize that with its use science provides a reliable, rigorous and unbiased way to gain knowledge of the natural world
2. Describe ecosystems in terms of how they vary, are structured, and function both internally and as part of the larger biosphere.
3. Describe human population characteristics and growth, and recognize the impacts of human society on Earth's systems and resources

GEC2: A. Introduction to Green engineering and Environmental issues

Unit	Description	Hours
1	**Foundation Course on Ecology & Environment:** Organizational level of ecological systems, Abiotic and biotic environment, limiting factors, adaptation, habitat and niche, holocoenotic nature of environment, concept of biosphere, population parameters, structure, growth regulation, interactions between populations, life history strategies (r and k species), the concept of carrying capacity. Structure and function of ecosystems, productivity, decomposition, energy flow, ecological efficiencies, global pattern of productivity.	**10**
2	**Environmental Pollution:** Types and major sources of air pollutants, air borne diseases and their effects on health. Types and major sources of water pollutants, water borne diseases with special reference to water pollution. Types and major sources of soil pollutants. Air, drinking water and waste water quality standard. Major sources of noise pollution, effects of noise pollution on health, noise level standard in industrial, commercial, residential and silence zones. Radioactive and thermal pollution sources and their effects on surrounding environment. Solid waste disposal and its effects on surrounding environment.	**11**
3	**Environmental Microbiology and Biotechnology:** Classification, characteristics, occurrence, distribution and ecological importance of microorganism. Photoautorophs, chemolithotrophs, organotrophs, parasites and their environmental importance. Soil microorganisms and their interactions relatives to soil fertility. Involvement of microbial communities in bio-degradation. Microbiological management of hazardous waste and wastelands. Biotechnological approaches and steps involved in conventional and advanced	**10**

	treatment technology. Release of genetically engineered microbes and environmental risk.	
4	**Restoration Ecology:** Ecology of Disturbed Ecosystems: disturbance and its impact on the structure and functioning of terrestrial and aquatic ecosystems. Aims and strategies of restoration: Concepts of restoration, single vs. multiple end-points; ecosystem reconstructions; physical, chemical, biological and biotechnological tools of restoration. Restoration of biological diversity: Acceleration of ecological succession, reintroduction of biota. Degradation and restoration of natural ecosystems: Forests, grassland. Savanna, aquatic. Restoration of degraded soils: Restoration of contaminated soils and soil fertility, mine spoil restoration.	**11**

References:

1. E.P. Odum and G.W. Barrett. 2005. Fundamentals of Ecology. Cengage Learning India Pvt. Ltd.
2. J.S. Singh, S.P. Singh and S.R. Gupta. 2008. Ecology, Environment & Resource Conservation. Anamaya Publications.
3. Raina M. Maier. 2000. Environmental Microbiology. Academic Press.
4. Pepper, I. and C. P. Gerba. 2004. Environmental Microbiology (2nd Edition). Academic Press.
5. Paul E Hardisty. 2010. Environmental and Economic Sustainability. CRC Press.
6. S.C. Santra. 2011. Environmental Science. New Central Book Agency.

Date Course Coordinator Subject Committee Chairperson

Dept Name: Biotechnology
Semester-IV
GEC2: B. Biology of Immune system

Course Title: **Biology of Immune system**	Course code: **21BTH4G2BL**
Total Contact Hours: (L-T-P): **2- 0 - 0**	Course Credits: **02**
Formative Assessment Marks: **20**	Duration of ESA/Exam**: 1 Hr.**
Summative Assessment Marks: **30**	

Course Outcomes (CO's):

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

1. Broaden the knowledge on immuno-structural Biology and in understanding the functional mechanism of immune systems
2. Elucidate the immune response of humans to foreign substances

GEC2: B. Biology of Immune system

Unit	Description	Hours
1	**Structure and function of the immune system:** The classification of human immune response: Early studies of humoral and cellular immunity, Innate and Adaptive immune response, Cellular components of the adaptive immune system, Phase of adaptive immune responses, Clonal expression, Toll like receptors, ABO Group.	**10**
2	**Cells of the immune system:** Lymphoid cells, clinical focus on the stem cells. Clinical uses and potential. B lymphocytes and T-lymphocytes. Natural killer cells. Mononuclear phagocytes. Phagocytosis is followed by digestion and presentation of antigen. Granulocytic cells, Mast cells, Dendritic cells. Follicular dendritic cells. Primary lymphoid organs. Secondary lymphoid organs.	**11**
3	**Antigen and Antibody:** Immunogenicity and antigenicity. Factors influencing immunogenicity. Types and characteristics of antigens: immunogens, Epitopes, haptens, Mitogens, Superantigens. Humoral Immunity Activation and differentiation of B cell. Germinal center activity. Structure, classification and function of antibodies. Isotypes, allotypes, ideotypes. Synthesis assembly and expression of immunoglobulin molecules. B cell receptor. Antibody response. Immunoglobulin Genes and Generation of antibody diversities.	**10**
4	**Cell Mediated Immunity:** T cell activation, differentiation and Maturation. Understanding self and non-self-discrimination. T cell sub types (cytotoxic, helper, regulatory). T cell receptors. Role and structure of MHC molecules. Antigen processing and presentation by MHC I and II molecules. Interaction of T cell receptor with MHC I and II peptides and antigens.	**11**

References:

1. Goldsby, R.A., Kindt, T.J., Osborne, B.A.. Kuby immunology. WH Freeman and Company. New York.
2. Janeway, C.A., Travers, P.,Walport,M., Capra, J.D. Immunobiology (6th Edition). Garland Science, New York.

3. Abbas, A.K., Lightman, A.K., Pober, J.S. Cellular and molecular immunology (Fifth edition). SC Publication.
4. Paul, W.E. Fundamentals of immunology. Raven Press New York.
5. Peters J.S, Baumgarten H. Monoclonal antibodies. Springer Verlag.
6. Roitt, I., Brostoff, J., Male, D. Immunology. HP Limited. NY.

Date Course Coordinator Subject Committee Chairperson

Dept Name: Biotechnology
Semester-IV
GEC2: C. Biotechnology for Human Welfare

Course Title: **Biotechnology for Human Welfare**	Course code: **21BTH4G2CL**
Total Contact Hours: (L-T-P): **2- 0 - 0**	Course Credits: **02**
Formative Assessment Marks: **20**	Duration of ESA/Exam: **1Hr.**
Summative Assessment Marks: **30**	

Course Outcomes (CO's):

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

1. Understand of how materials are provided by biological agents to provide goods and services.
2. Elucidate about biotechnology in improving health care for human beings

GEC2: C. Biotechnology for Human Welfare

Unit	Description	Hours
1	**Industry:** An overview of application of biotechnology in industry; Enzymes for textile industry, breweries and food supplements: single cell proteins, vitamins. food processing: cheese, yoghurt making, Biodegradable plastics, biofuels.	**10**
2	**Environment:** Application of biotechnology in environmental aspects: Waste management, biodegradation of heavy metals, water cleaning, removing of oil spills, bioremediation, air and soil pollution and biomining.	**11**
3	**Forensic science and health:** Forensic science: Application of biotechnology in forensic science: Solving crimes by using DNA finger printing techniques Health: Antibiotic production, molecular diagnostics, Vaccines and vaccine delivery, recombinant therapeutics- Insulin, gene therapy. human genome project	**11**
4	**Application in livestock improvement:** Transgenic animals, clones, Animal vaccine production, increased milk production, artificial Insemination, poultry and fisheries.	**10**

References:

1. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology.2nd edition. Panima Publishing Co. New Delhi.
2. Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
3. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.
4. Environmental Biotechnology, Pradipta Kumar Mohapatra
5. Environmental Biotechnology – Concepts and Applications, Hans-Joachim Jordening andJesef Winter
6. B.B. Nanda and R.K. Tiwari, Forensic Science in India: A Vision for the Twenty First Century, Select

Publishers, New Delhi (2001).
7. M.K. Bhasin and S. Nath, Role of Forensic Science in the New Millennium, University of Delhi, Delhi (2002).
8. S.H. James and J.J. Nordby, Forensic Science: An Introduction to Scientific and Investigative Techniques, 2nd Edition, CRC Press, Boca Raton (2005).
9. W.G. Eckert and R.K. Wright in Introduction to Forensic Sciences, 2nd Edition,
10. W.G.Eckert (ED.), CRC Press, Boca Raton (1997).

Date Course Coordinator Subject Committee Chairperson

Dept Name: Biotechnology
Semester-IV
DSC11P9: Plant and Animal Biotechnology lab

Course Title: **Plant and Animal Biotechnology lab**	Course code: **21BTH4C11P**
Total Contact Hours: (L-T-P): **0- 0 - 4**	Course Credits: **02**
Formative Assessment Marks: **20**	Duration of ESA/Exam: **04 Hrs.**
Summative Assessment Marks: **30**	

Course Outcomes (CO's):

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

1. Gain basic skills in plant and animal biotechnology.
2. Practices the various applications of animal biotechnology, plant tissue culture, plant and animal genomics, genetic transformation and molecular breeding of plants and animals.

DSC11P9: Plant and Animal Biotechnology lab

Experiment's
1. Prepare culture media with various supplements for plant tissue culture.
2. Micropopagation through node and shoot tip explants
3. Organ development from cultured tissue
4. Induction of somatic embryo
5. Culture of mature embryos and endosperm
6. Initiation and maintenance of callus
7. Preparation of synthetic seeds and *in vitro* germination
8. Isolate plant protoplast by enzymatic and mechanical methods and attempt fusion
9. by PEG (available material)
10. Attempt *in vitro* andro and gynogenesis in plants (*Datura stramonium*)
11. Establishment of cell suspension culture from the friable callus
12. Preparation of Dulbecco's Modified Eagle's medium for mammalian cell culture.
13. Count cells of an animal tissue and check their viability (Trypan Blue method)
14. Prepare single cell suspension from spleen and thymus
15. Trypsinization and storage of cell line

16. Cryopreservation of mammalian cell
17. Monitor and measure doubling time of animal cells.
18. Transfection of mammalian cell by calcium phosphate co-precipitation method.

References:

1. Butler M. 1987. Animal cell technology- Principles and procedures. Open University press, New York
2. Darling D.C. and S.J Morgan. 1994. Animal cell cultures and media. BIOS scientific Publishers Ltd, London. Ed. Martin Clynes. 1998. Animal Cell Culture Techniques. Springer, Heidelberg.
3. Gamborg O.L and Philips, G.C. 1995. Plant Cell, Tissue and organ culture Fundamental methods. Narosa Publishing House, New Delhi.

Note:

1. Minimum of EIGHT experiments must be carried out.
2. Experiments may be added as and when required with the approval of BoS.

Date Course Coordinator Subject Committee Chairperson

Dept Name: Biotechnology
Semester-IV
Project: 21BTH4C1R: Research Project

Course Title: **Research Project**	Course code: **21BTH4C1R**
Total Contact Hours: (L-T-P): **0- 0 - 8**	Course Credits: **04**
Formative Assessment Marks: **30**	Duration of ESA/Exam: **04 Hrs.**
Summative Assessment Marks: **70**	

Course Outcomes (CO's):

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

1. Address and assess the diverse problems associated with various fields relevant to biotechnology through the techniques learnt to design managerial measures for a healthy environment

"The candidate should submit an independent hard bond form of project report by the end of final year course on a topic relevant Biotechnology, based on the laboratory experiments/case studies/field studies carried out in a Biotechnology/related industry, it will be evaluated by external and internal examiners. It will be carried out 4th semester, but will be started in the 3rd semester. Three copies of the project report shall be submitted to the chairman, Department of Biotechnology before one week of the theory examination of fourth semester".