VIJAYANAGARA SRI KRISHNADEVARAYA UNIVERSITY

JNANASAGARA CAMPUS, BALLARI-583105

DEPARTMENT OF STUDIES IN BIOTECHNOLOGY

SYLLABUS

MASTER OF SCIENCE

(I-IV Semester)

09/10/2024

Chairman
OS in Biotechonology (PG)
partment of PG. Studies and
Research in Biotechnology
yanagara Sri Krishnadevaraya
niversity, BALLARI - 583105.

With effect from

2024-25

9/10/2024

9/10/20

VIJAYANAGARA SRI KRISHNADEVARAYA UNIVERSITY, BALLARI-583 105

Distribution of Courses/Papers in Postgraduate Programme I to IV Semester as per Choice Based Credit System (CBCS) Proposed for PG Programs

DEPARTMENT OF STUDIES IN BIOTECHNOLOGY

Programme Educational Objectives (PEOs)

PEO1	Students will gain necessary knowledge and develop specialized skills in the different areas of Biotechnology.
PEO2	Students will think critically and creatively about the use of biotechnology to address local and global problems.
PEO3	Students will be able to implement the scientific skills for development of industrial applications and entrepreneurship.

Program Outcomes (POs)
At the end of the program, a student should be able to:

PO1	Carry out research /investigation independently in specialized area of Biotechnology.
PO2	Write and present a substantial technical report/document.
PO3	Demonstrate a degree of mastery in the area of biotechnology to enable them in collaborative and multidisciplinary research.
PO4	Recognize the need for continuous learning and will prepare oneself to create, select, learn and apply appropriate techniques, resources, and modern instrumentation to solve complex biotechnological activities with an understanding of the limitations.
PO5	Demonstrate knowledge of biotechnology and management principles and apply to manage projects efficiently and economically with intellectual integrity and ethics for sustainable development of society.

VIJAYANAGARA SRI KRISHNADEVARAYA UNIVERSITY

DEPARTMENT OF STUDIES IN BIOTECHNOLOGY

JNANASAGARA CAMPUS, BALLARI-583105

I-SEMESTER

Semester No.	Category	Subject code	Title of the Paper	Marks			Teaching hours/week			Credit	Duration of exams (Hrs)
				IA	Sem. Exam	Total	L	T	P		
FIRST	DSC1	24BTH1C1L	Cell and Molecular Biotechnology	30	70	100	4	-	-	4	3
	DSC2	24BTH1C2L	Advanced Genetics	30	70	100	4	-	-	4	3
	DSC3	24BTH1C3L	Principles of Biochemistry	30	70	100	4	-	-	4	3
	DSC4	24BTH1C4L	General Microbiology	30	70	100	4	-	-	4	3
	SEC1	24BTH1S1LP	Instrumentation & Biotechniques	20	30	50	1	-	2	2	1
	DSC1P1	24BTH1C1P	Molecular and Genetics lab	20	30	50	-	-	4	2	4
	DSC3P2	24BTH1C3P	Biochemistry lab	20	30	50	-	-	4	2	4
	DSC4P3	24BTH1C4P	Microbiology lab	20	30	50	-	-	4	2	4
Total Marks for I Semester						**600**				**24**	

II-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		
SECOND	DSC5	24BTH2C5L	Immunology and Immunodiagnostic	30	70	100	4	-	-	4	3
	DSC6	24BTH2C6L	Genomics and Genetic Engineering	30	70	100	4	-	-	4	3
	DSC7	24BTH2C7L	Bioprocess Engineering and Technology	30	70	100	4	-	-	4	3
	DSC8	24BTH2C8L	Stem cell technology and Regenerative medicine	30	70	100	4	-	-	4	3
	SEC2	24BTH2S2LP	Biopharmaceutical Techniques	20	30	50	1	-	2	2	1
	DSC5P4	24BTH2C5P	Immunology and Immunodiagnostic lab	20	30	50	-	-	4	2	4
	DSC6P5	24BTH2C6P	Genomics and Genetic Engineering lab	20	30	50	-	-	4	2	4
	DSC7P6	24BTH2C7P	Bioprocess Engineering and Technology lab	20	30	50	-	-	4	2	4
Total Marks for II Semester						**600**				**24**	

III-SEMESTER

Semester No.	Category	Subject code	Title of the Paper	Marks			Teaching hours/week			Credit	Duration of exams (Hrs.)
				IA	Sem. Exam	Total	L	T	P		
THIRD	DSC9	24BTH3C9L	Biostatistics and Bioinformatics	30	70	100	4	-	-	4	3
	DSC10	24BTH3C10L	Medical Biotechnology and Diagnostics	30	70	100	4	-	-	4	3
	DSE1	24BTH3E1AL	A: Pharmaceutical Biotechnology and drug designing	30	70	100	4	-	-	4	3
		24BTH3E1BL	B: Microbial Biotechnology								
		24BTH3E1CL	C: Biofuels and Bioenergy								
	DSE2	24BTH3E2AL	A: Agriculture Biotechnology	30	70	100	4	-	-	4	3
		24BTH3E2BL	B: Food Technology and Nutrigenomics								
		24BTH3E2CL	C: Marine Biotechnology								
	GEC1	24BTH3G1AL	A: Introduction to Biomaterials	20	30	50	2	-	-	2	1
		24BTH3G1BL	B: Gene expression and Transgenics								
		24BTH3G1CL	C: Biomedical Waste Management								
	SEC3	24BTH3S3 LP	Research Methodology	20	30	50	1	-	2	2	1
	DSC9P7	24BTH3C9P	Biostatistics and Bioinformatics lab	20	30	50	-	-	4	2	4
	DSC10P8	24BTH3C10P	Medical Biotechnology and Diagnostics lab	20	30	50	-	-	4	2	4
			Total Marks for III Semester			**600**				**24**	

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	24BTH4C11L	Plant Biotechnology	30	70	100	4	-	-	4	3
	DSC12	24BTH4C12L	Animal Biotechnology	30	70	100	4	-	-	4	3
	DSE3	24BTH4E3AL	A: Biosafety, Bioethics and IPR	30	70	100	4	-	-	4	3
		24BTH4E3BL	B: Environmental Bioengineering								
		24BTH4E3CL	C: Enzyme Technology								
	DSE4	24BTH4E4AL	A: Nanobiotechnology	30	70	100	4	-	-	4	3
		24BTH4E4BL	B: Proteomics and Protein Engineering								
		24BTH4E4CL	C: Cell signaling								
	GEC2	24BTH4G2AL	A: Introduction to Green engineering and Environmental issues	20	30	50	2	-	-	2	1
		24BTH4G2BL	B: Biology of Immune system								
		24BTH4G2CL	C: Biotechnology for Human Welfare								
	DSC11P9	24BTH4C11P	Plant and Animal Biotechnology lab	20	30	50	-	-	4	2	4
	Project	24BTH4C1R	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-I
DSC1: Cell and Molecular Biotechnology

Course Title: **Cell and Molecular Biotechnology**	Course code: **24BTH1C1L**
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. Apply knowledge of cell biology and molecular Biology in various cellular functions, inculcate a knowledge of various issues related to molecular cell biology, the application and research involved in functioning of the different cell organelles.
2. Design and analyses the experiments related with the different molecules involved in cell biology and use of the various techniques in the molecular cell biology to study the kinetics and rationale behind each phenomenon.
3. Identify, formulate, and solve problems arisen due to the inefficient functioning of the various life processes like cell-to-cell communication, cell cycle regulation, movement processes of a cell or system.
4. Use the techniques, skills, and modern tools necessary for imbalances in various life processes, design a molecular cell biology research project, collect and analyze data, and interpret results

DSC1: Cell and Molecular Biotechnology

Unit	Description	Hours
1	**Membrane structure and Transport:** Chemical composition of membrane, structure and function of membrane protein, membrane lipid and fluidity, lipid rafts, deformation of membranes. Transport across membrane: Transport of small molecules: Passive and active transport (P, V, F and ABC transporters); transport of large molecules: endocytosis and exocytosis. Protein sorting and vesicular trafficking: Transport of molecules into and out of the nucleus, transport of proteins into mitochondria and chloroplasts, transport from the ER through Golgi apparatus to lysosomes	**11**
2	**Cytoskeleton, Interaction of Cells and their Environment:** Cytoskeleton, Cytoskeleton proteins, Microfilaments: types, structure and function, Intermediate: structure and function, Microtubule: structure and functional organization, Cell interaction: Interaction between cell and extracellular matrix (ECM), ECM proteins (collagens, elastin, proteoglycans, fibronectins and laminins); Interaction between cells: Tight junction, anchoring junction, gap junction, Cell adhesion molecules: seletins, cadarins,	**11**

	immunoglobins	
3	**Cell Signaling, Cell Cycle and Cell Death:** Cell Signaling and communication: general principle of communication, Cell surface receptors, G-protein mediated signaling, camp, receptors tyrosine kinases, second messengers, Cell cycle: overview, model organism and methods to study cell cycle, regulation of cell cycle, Cell death: apoptosis, necrosis, caspases, cell death pathways.	**11**
4	**Replication and Transcription in Prokaryotes and Eukaryotes:** Chemical composition of DNA/RNA. DNA structure, DNA denaturation and renaturation. DNA replication: Mechanism of DNA replication in prokaryotes and eukaryotes. Transposable elements, Mechanisms of transposition. Structural features of prokaryotic and eukaryotic RNA - rRNA, tRNA, mRNA. Prokaryotic transcription: promoters and regulatory elements; RNA polymerase; initiation, elongation and termination; transcriptional regulation-positive and negative; operon concept-lac and trp operons. Eukaryotic transcription; promoters and regulatory elements; RNA polymerase structure and assembly; RNA polymerase I, II, III; initiation, elongation and termination. Post-transcriptional modifications: 5'-cap formation, 3'-end processing, splicing, RNA editing, catalytic RNA. Regulatory RNA: antisense RNAs, micro RNAs, RNA interference.	**12**
5	**Translation in Prokaryotic and Eukaryotic:** Genetic code: Salient features, Universal genetic code; Wobble hypothesis. Translation: Mechanism of initiation, elongation and termination of translation process. Regulation of protein synthesis, Polyribosomes, Post-translational modifications; Transport of proteins and molecular chaperones; protein stability and degradation pathways.	**11**

References:

1. Molecular biology of the cell, 6th edition (2014), B.Alberts.,A. Johnson., J. Lewis., D.Morgan. and M. Raff, Garland Science, New York, USA. ISBN:978-0815344322.
2. Molecular cell biology, 7th edition (2013), H.Lodish., A. Berk., C.A. Kaiser and M.Krieger, W H Freeman and Company, New York, USA. ISBN:9781429234139.
3. Cell: molecular approach, 6thedition (2013), G.M. Cooper and R.E. Hausman, ASM Press, USA. ISBN:978-0878939640.
4. Cell and Molecular Biology, 7thedition (2013), G. Karp, John Wiley, New York, USA. ISBN: 9781118301791.
5. Cell biology, 2ndedition (2008), T.D. Pollard and W.C. Earnshaw, Saunders, USA.

ISBN:9781416022558.

6. Cell and Molecular Biology. 3rdedition (2010),S.C Rastogi, New Age International publishers, India ISBN-10: 8122430791

Date: 09/10/24 Course Coordinator Subject Committee Chairperson

Dept Name: Biotechnology
Semester-I
DSC2: Advanced Genetics

Course Title: **Advanced Genetics**	Course code: **24BTH1C2L**
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. Describe the fundamental genetic inheritance patterns.
2. Understand relationship between phenotype and genotype in human genetic traits.
3. Understand and demonstrate the drawing of human pedigree charts for genetic disorders.
4. Develop capacity to solve quantitate and qualitative data based genetic problems

DSC2: Advanced Genetics

Unit	Description	Hours
1	**Introduction to genetics:** Mendel's principles, Gene interaction & Modified ratios, Multiple alleles, multiple factor inheritance, Extra chromosomal inheritance. Linkage and crossing over and genetic mapping: sex-linked inheritance, cytological evidence of crossing over in maize, crossing over frequency and map distances, recombination models: maize, yeast and Neurospora. Population genetics: Hardy –Weinberg's law, factors influencing the equilibrium	**11**
2	**Organization of genomes:** Prokaryotic genome organization - Bacteriophages, Bacteria, Viruses. Eukaryotic organelle genomes, Eukaryotic nuclear genomes (Genetic features, C-value paradox, types of coding and noncoding sequences and Split Genes). Mobile genetic elements in Prokaryotes (bacteria) and Eukaryotes (Drosophila, maize and humans).	**11**
3	**Genetic mapping of Mendelian traits:** History of human genetics, Pedigree, Pattern of inheritance. Identifying recombinants and non-recombinants in pedigrees, somatic cell fusion, cell hybrids and Radiation hybrids. Genetic and physical map distances, Two point mapping - LOD score analysis. Multipoint mapping. Homozygosity mapping. Genetic mapping of complex traits, Difficulties in	**11**

	mapping complex traits, Integration of Cytogenetic, genetic and physical maps.	
4	**Genetic basis of syndromes and disorders:** Monogenic diseases, Inborn errors of metabolism, Neurogenetic disorders, Genetic disorders of Haemopoietic systems, Genetic disorders of eye, Genetic disorders in skeleton and skin, Congenital heart diseases, Complex polygenic syndromes (Atherosclerosis, Diabetes mellitus and Rheumatoid Arthritis), Learning disorders.	**11**
5	**Diagnosis, Genetic counseling and ethics:** Prenatal diagnosis: (i) Noninvasive methods- X- radiation, Ultrasonography and Fetal echocardiography (ii) Invasive methods- Maternal serum screening, Amniocentesis, Chorionic villus sampling and Fetoscopy. Genetic counseling: Definition, Models of eugenics and human right, Psychotherapeutic counseling, Decision making, Risk assessment and counseling in Mendelian and multifactorial syndromes. Human genetics and legal, social and ethical considerations.	**12**

References:

1. Gardner E J & D P Snustad 1996. Principles of Genetics. John Willey, New York.
2. Sambamurthy, AVSS. 1999. Genetics. Narosa publ. New Delhi.
3. Stansfield WD 1991. Theory & Problems in genetics. McGraw Hill, New York.
4. Strickberger MW 1996. Genetics III edn. McMillan, New York.
5. Winchester AM 1967. Genetics. Oxford & IBH. New Delhi.
6. Cummings, M. R. 1994. Human Heredity: Principles and Issues. West Publishing Company.
7. Epstein, R. J. 2003. Human Molecular Biology. Cambridge Univ. Press, Cambridge
8. Jobling M. A., Hurles and Tyler-Smith. 2004. Human Evolutionary Genetics – Origin, People & Disease. Garland & Science
9. Khoury, M. J., J. Little and W. Burke. 2004. Human Genome Epidemiology. Oxford Univ. Press, Oxford.
10. Motulsky, V. 1977. Human Genetics. Springer & Verlag, Berlin.
11. Strachan, T. and A. P. Reads, 2004. Human Molecular Genetics 3. Garland Science, London.

Date: 09/10/24 Course Coordinator Subject Committee Chairperson

Dept Name: Biotechnology
Semester-I
DSC3: Principles of Biochemistry

Course Title: **Principles of Biochemistry**	Course code: **24BTH1C3L**
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. To demonstrate the structural and functional role of biomolecules essential for cellular reactions.
2. Illustrate the catalytic mechanisms involved in synthesis of chemical energy from biomolecules.
3. Explain the physiological significance of anabolic and catabolic pathways used to drive
   cellular functions.
   Enlist the chemical and biological differences between DNA, RNA and their role in cellular behavior

DSC3: Principles of Biochemistry

Unit	Description	Hours
1	**Chemical foundations of biology:** The chemical unity of diverse living organisms, composition of living mater. Water - Physio-chemical properties of water. Biomolecular reactions. Macromolecules and their monomeric subunits, Bioenergetics - laws of thermodynamics, Gibb's Free energy, Activation energy, exergonic and endergonic reactions, biological energy transductions. Enzymes - nomenclature, classification, principle, regulation and mechanisms of enzyme catalysis, enzyme kinetics- MM equation, LB plot, Inhibition. Introduction to Metabolisms - Anabolism and Catabolism, Experimental approaches to study metabolism.	**12**
2	**Carbohydrates:** Classification, Structure and Isomerism. Monosaccharides, Oligosaccharides, Polysaccharides- Structure and Properties. Metabolism of Carbohydrates- Glycolysis, Citric acid cycle, HMP shunt, Glucuronic acid pathway, Gluconeogenesis, Glycogenesis, Glycogenolysis, Glyoxylate cycle, Regulations of Glycolysis and Gluconeogenesis. Metabolism of Amino sugars, Sialic acids, Mucopolysaccharides and Glycoproteins.	**11**

3	**Amino acids:** Structures, classification, properties. Biosynthesis of Aspartate, Pyruvate and Aromatic amino acids families. Amphibolic activity of amino acids. Protein - classification, types, characteristics and structures, functions. Methods for determining protein conformations. Symmetry and functional properties, Protein folding, Denaturation & Renaturation, Ramachandran plot, Solid state synthesis of peptides, Sequence determination. Degradation of Proteins and Amino acids, Urea cycle and its significance.	**11**
4	**Lipids:** Classification, sources and biological functions. Biosynthesis of fatty acids and its regulation, Hydroxy fatty acids, Acylglycerols. Membrane lipids- Phospholipids, Sphingolipids & Eicosanoids. Cholesterol biosynthesis and its regulation. Fatty acid degradation. Lipoproteins-types and functions. Methods of inter organ transport of fatty acids. Formation of ketone bodies. Classification, structure and physiological roles of Vitamins.	**11**
5	**Nucleic acids:** Nitrogenous bases, nucleosides & nucleotides, Structure of RNAs and DNA, Forces stabilizing nucleic acid structures. Fractionation and chemical synthesis of oligonucleotides. Denaturation and Hybridization. Synthesis and Catabolism of Purines and Pyrimidines, Synthesis of Deoxy ribonucleotides. Biosynthesis of nucleotide coenzymes, nucleotide degradation. Intermediary metabolism.	**11**

References:

1. Principles of Biochemistry by A.L.Lehninger, 2 Ed. (worth), 2015
2. Lehninger Principles of Biochemistry by Nelson, D and Cox, D. Macmillon Pub, 2017
3. Biochemistry by L.Stryer 5 Ed. (Freeman-Toppan), 2015
4. Text Book of Biochemistry by West et. al., (Mac Millan), 2012
5. Principles of Biochemistry by Smith et. al., (Mc Graw Hill), 1983
6. Harper's Biochemistry (Langeman), 2018
7. Biochemistry by D.Voet and J.G.Voet (John weily).
8. Enzymes by Palmer (East), 2008
9. Biochemistry by U. Satyanarayana (Books & Allied (P) Ltd), 2008
10. Nelson, D. L., & Cox, M. M. (2024). Lehninger Principles of Biochemistry (8th ed.). W.H. Freeman and Company.

11. Voet, D., Voet, J. G., & Pratt, C. W. (2024). Fundamentals of Biochemistry: Life at the Molecular Level (6th ed.). Wiley.
12. Berg, J. M., Tymoczko, J. L., & Gatto, G. J. (2024). Biochemistry (9th ed.). W.H. Freeman and Company.
13. Schomburg, D., & Schomburg, I. (2024). Springer Handbook of Enzymes. Springer.
14. Copeland, R. A. (2024). Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis (3rd ed.). Wiley.
15. Voet, D., Voet, J. G., & Pratt, C. W. (2016). Fundamentals of biochemistry: Life at the molecular level (5th ed.). John Wiley & Sons.
16. Nelson, D. L., & Cox, M. M. (2017). Lehninger principles of biochemistry (7th ed.). W.H. Freeman.
17. Berg, J. M., Tymoczko, J. L., Gatto, G. J., & Stryer, L. (2015). Biochemistry (8th ed.). W.H. Freeman.
18. Garrett, R. H., & Grisham, C. M. (2016). Biochemistry (6th ed.). Cengage Learning.
19. Mathews, C. K., van Holde, K. E., Appling, D. R., & Anthony-Cahill, S. J. (2012). Biochemistry (4th ed.). Pearson

Date: 09/10/24 Course Coordinator Subject Committee Chairperson

Dept Name: Biotechnology
Semester-I
DSC4: General Microbiology

Course Title: **General Microbiology**	Course code: **24BTH1C4L**
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. Establish an understanding of the basic techniques (concept of aseptic work, cultivation and identification) in microbiology.
2. Describe different aspects of microbial nutrition and growth.
3. Describe microbial interactions and their significance in environment.
4. Describe nonspecific body defenses and the immune responses and apply this understanding to the infectious disease process as well as the prevention and control of infectious diseases.
5. Develop and execute oral and writing skills necessary for effective communication of the course, the ability to think critically regarding a topic and the delivery of scientific principles to both scientists and non-scientists community.

DSC4: General Microbiology

Unit	Description	Hours
1	**History and Classification of Microorganisms:** Systematic position of microorganisms in living world, classification of microorganisms: Hackle's three kingdom concept, Whittaker's five kingdom concept, three domain concept of Cral Woese. Historical account of bacterial classification, detail account of bacterial classification according to the 1st edition of Bergy's manual of systematic bacteriology (up to sections). Detail account of bacterial classification according to the 2nd edition of Bergy's manual of systematic bacteriology (up to orders).	**11**
2	**Bacteria and Archaea:** Morphology and ultra-structure of bacteria; morphological types: L-forms. Structure and function of cell components: bacteria and archaeal cell wall; bacteria and archaeal flagella; fimbriae and pili; capsule- type, slime layers; cell inclusions; nucleoid. Endospore: structure,	**11**

	formation and germination of bacterial endospore. Bacteria growth: growth requirements-nutritional and environmental factors; types of culture media; aerobic and anaerobic culture; shaker and still culture; batch, continuous and synchronous culture; growth kinetics, growth curve and measurement of growth.	
3	**Fungi and Algae:** Structure, reproduction and classification of fungi, general characteristics of Myxomycetes, Zygomycetes, Ascomycetes, Basidiomycetes, and Deuteromycetes. Fungal growth: culture media for fungal growth, growth requirements and parameters affecting growth; Economic importance of fungi. Algae: distribution, classification, nutrition, structure and reproduction; green algae, diatoms, euglenoids, brown and red algae.	**11**
4	**Protozoa and Acellular forms:** Protozoa: distribution, classification, nutrition, structure and reproduction. Discovery and origin of viruses. General properties of viruses: morphology, ultra-structure, capsid and their arrangements, types of envelopes and their composition and life cycle. Cultivation of viruses: embryonated eggs, experimental animals and cell lines. Composition, replication and significance of viroids and prions.	**11**
5	**Staining and Control of Microorganisms:** Gram's staining, Acid fast, Metachromatic granules, nuclear staining, capsule, silver impregnation, Flagella and other special staining methods. Microbial death curve, concept of bioburden, thermal death time and decimal reduction time. Factors influencing the effectiveness of antimicrobial agents. Genetics of antibiotic resistance. Control of microorganisms by physical agents: heat, filtration and radiation. Chemical control of microorganisms: Halogens, phenol and other phenolic compounds, heavy metals, alcohols, ethylene oxide and aldehydes.	**12**

References:

1. Prescott's Microbiology 9th edition (2014) M.J .Willey,M.L.Sherwood, M.L. and J.C. Woolverton, McGraw-Hill Companies. Inc. New York.ISBN: 9780077510664
2. Microbiology, 8th edition. (2013) G.J. Black, John Wiley & Sons, USA.ISBN: 9781118213414
3. Microbiology, 5th edition. (1993) J.M.Pelczar, E.C.S. Chan, and R.N. Krieg, McGraw –Hill Companies, Inc. New York.ISBN:9780074623206
4. Brock Biology of Microorganisms, 14th edition. (2014) T.M.Madigan, M.J.Martinko, S.K.Bender, H.D.Buckley, A.D.Stahl and T.Brock, Pearson Education, Inc. San Francisco.ISBN: 9781292068312
5. Introductory mycology. 4th Edition (2002) C.J.Alexapoulos, C.W.Mims and M.Blackwell, Wiley

India.ISBN :9788126511082

6. Textbook of Microbiology, 8th edition (2010) R. Ananthanarayan and J.C.K.Panikar, University Press Private Limited, India. ISBN: 978-9350905340
7. Microbiology: A Laboratory Manual, 11th Edition (2017) J.G.Cappuccino, and N.Sherman Pearson,USA. ISBN: 978-0321840226.

Date: 09/10/24 Course Coordinator Subject Committee Chairperson

Dept Name: Biotechnology
Semester-I
SEC1: Instrumentation & Biotechniques

Course Title: **Instrumentation & Biotechniques**	Course code: **24BTH1S1LP**
Total Contact Hours: (L-T-P): **1- 0 - 2**	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. Familiarity with working principals, tools and techniques of analytical techniques.
2. Apprehend the functioning, maintenance and safety aspects of the apparatus used in a Biotechnology lab.
3. Assimilate the principles and applications of centrifuge, electrophoresis, chromatography and spectroscopy in research and related experiments.
4. To understand the strengths, limitations and creative use of techniques for problem solving.

SEC1: Instrumentation & Biotechniques

Unit	Description	Hours
1	**Basic techniques:** Electrochemistry: pH and buffers, potentiometric and conductometric titration. Principle and application of light, phase contrast, fluorescence, scanning and transmission electron microscopy, scanning tunneling microscopy, atomic force microscopy, confocal microscopy, cytophotometry and flow cytometry. Preparation of microbial, animal and plant samples for microscopy. Centrifugation: Basic principle and application; Differential, density and Ultracentrifugation. Electrophoresis: Principle and applications of Native and SDS PAGE; Agarose and 2D gel electrophoresis.	**07**
2	**Chromatography and Spectroscopy techniques:** Theory of Chromatography; Migration. Dispersion. Chromatographic Resolution. Types: Gel filtration, Paper, thin-layer and partition chromatography. Affinity Chromatography: Ion Exchange chromatography, Purification of specific groups of molecules (GST fusion proteins, Poly (His) fusion proteins, Tandem affinity purifications). Chromatin Immunoprecipitation Assay (ChIP assay), Chip Seq. Spectroscopy: principle, instrumentation and application of	**07**

	UV-visible, fluorescent, CD, NMR, ESR spectroscopy, atomic absorption spectroscopy, Plasma emission spectroscopy, X-ray diffraction, Mass spectroscopy, MALDI-TOF.	
3	**Practical's** Laboratory 1: To prepare an Acetic-Na Acetate Buffer and validate the Henderson-Hasselbach equation. Laboratory 2: To determine an unknown protein concentration by plotting a standard graph of BSA using UV-Vis Spectrophotometer and validating the Beer- Lambert's Law. Laboratory 3: Titration of Amino Acids and separation of aliphatic, aromatic and polar amino acids by thin layer chromatography. Laboratory 4: Separation of cell organelles using gradient centrifuging techniques. Laboratory 5: Immunochromatographic assay, Enzyme-linked immunosorbent assay Laboratory 6: In-situ hybridization Laboratory 7: Western blotting Laboratory 8: Conventional PCR Laboratory 9: Real time PCR quantification	**28**

References:

1. Cappuccino, J. G., & Welsh, C. (2016). Microbiology: a Laboratory Manual. Benjamin- Cummings Publishing Company. ISBN: 978-0321840226.
2. Molecular Diagnostics: Current Research and Applications (2014), T, J. Hugget and O' Grady, J. Caister Academic Press. ISBN: 9781908230645.
3. Molecular Cloning: A Laboratory Manual, 4th edition (2014), R. G. Michael, Cold Spring Harbor Laboratory Press, ISBN: 978-1-93611.
4. Shrama BK, Instrumental method of chemical analysis
5. DA Skoog. Instrumental methods of analysis
6. Plummer, An introduction to practical Biochemistry
7. Chatwal and Anand, Instrumentation

Date: 09/10/24 Course Coordinator Subject Committee Chairperson

Dept Name: Biotechnology
Semester-I
DSC1P1: Molecular and Genetics Lab

Course Title: **Molecular and Genetics Lab**	Course code: **24BTH1C1P**
Total Contact Hours: (L-T-P): **0- 0 - 4**	Course Credits: **02**
Formative Assessment Marks: **20**	Duration of ESA/Exam: **4 Hrs.**
Summative Assessment Marks: **30**	

Course Outcomes (CO's):

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

1. Apply skills in genetics, cell and molecular biology that are generally useful in biological and medical research.
2. Demonstrate an understanding of some basic molecular genetic techniques.
3. Demonstrate nucleic acid extraction, resolution, and detection.

DSC1P1: Molecular and Genetics Lab

Experiment's
1. Preparation of cytological studies for identification of stages of mitosis using root tips
2. Preparation of cytological studies for identification of stages of meiosis–I using flower buds: chiasma frequency
3. Comparative assessment of mitotic indices and karyotyping
4. Demonstration of chromosomal (structural and numerical) aberrations
5. Cell cycle analysis using flow cytometry
6. Analysis of apoptosis and necrosis using flowcytometry / fluorescence microscopy.
7. Safety consideration in a molecular biology laboratory
8. Isolation of Genomic DNA from bacteria and plant material
9. Isolation of RNA from yeast and plant tissue
10. Calculations in Molecular biology: -
(a) Calculating DNA in mM and conversion to picomoles
(b) Oligonucleotide Quantitation
(c) Calculating Molecular weight of a vector

(d) Calculations in Oligonucleotide synthesis

(e) Calculating Tm and concentration of primers.

11. Induction of Human leukocyte culture.
12. Preparation of Human chromosomes and G banding.
13. Karyotyping of normal chromosomes and syndromes.
14. Creation of pedigrees and study on patterns of Inheritance in man – numerical on pedigree analysis- autosomal patterns, X–linked patterns, Y–linked patterns, mitochondrial inheritance patterns
15. Studies on phenotypes of different diseases and syndromes.
16. Barr body analysis.

References:

1. Molecular Cloning, Laboratory Manual, Maniatis, E.F. Fritsch and J. Sambrook (Cold Spring Harber Laboratory, New York).
2. Techniques in Molecular Biology (1992), J. Walker and W. Castra (GeomHelns, London).
3. Practical Methods in Molecular Biology (1991), R.F. Schecleif and PC. Wensik (SpringerVerlag).
4. Sharma AK & A Sharma. 1980. Chromosome techniques: Theory & Practice. Batterworth.

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: 09/10/24 Course Coordinator Subject Committee Chairperson

Dept Name: Biotechnology
Semester-I
DSC3P2: Biochemistry Lab

Course Title: **Biochemistry Lab**	Course code: **24BTH1C3P**
Total Contact Hours: (L-T-P): **0- 0 - 4**	Course Credits: **02**
Formative Assessment Marks: **20**	Duration of ESA/Exam: **4 Hrs.**
Summative Assessment Marks: **30**	

Course Outcomes (CO's):

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

1. Analyze and identify the protein and carbohydrate concentrations by using qualitative and quantitative methods.
2. Choose appropriate analytical techniques to study biomolecules at research labs and industries.
3. To understand the strengths, limitations and creative use of techniques for problem solving.

DSC3P2: Biochemistry Lab

Experiment's
1. Preparation of Standard solutions (Molar & Normal) and various buffers.
2. Preparation of Titration curve & determination of pKa values for and amino acids (Glycine).
3. Differential estimations of carbohydrates - reducing vs non-reducing.
4. Estimation of sugars by DNS method.
5. Colorimetric estimation of amino acids by Ninhydrin reagent
6. Colorimetric estimation of protein by Bradford & Folin-Ciocalteu's reagent.
7. Estimation of RNA by Orcinol method.
8. Estimation of DNA by Diphenylamine method
9. Estimation of vitamin C by dichlorophenol indophenol method
10. Chromatography: Column Chromatography - Separation of Photosynthetic Pigments and recording their absorption spectra in the visible range.
11. Separation of amino acids / sugars by Ascending Paper Chromatography.

12. Separation of lipids/ sugars/amino acids by Thin Layer Chromatography.
13. Enzyme Kinetics
    (a) Phosphatase assay (Rat liver)
    (b) Protease assay (Bacterial / fungal cell)
14. Determination of Km and Vmax of alkaline phosphatase / salivary amylase
15. pH of the reaction medium and the Enzyme velocity.
16. Temperature of the reaction medium and the Enzyme velocity.
17. Enzyme concentration in the reaction medium and the Enzyme velocity.

References:

1. Hawk's physiological chemistry Ed. by Oser (Mc Graw Hill).
2. Biochemical methods By Sadasivam and Manikam (Wiley Eastern limited).
3. An introduction to practical biochemistry by D.T.Plummer (Mc Graw Hill).
4. Laboratory manual in Biochemistry by J.Jayaraman (Wilety Eastern limited).
5. Biochemistry - a laboratory courses by J.M.Beckar (Academic Press).

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: 09/10/24 Course Coordinator Subject Committee Chairperson

Dept Name: Biotechnology
Semester-I
DSC4P3: Microbiology Lab

Course Title: **Microbiology Lab**	Course code: **24BTH1C4P**
Total Contact Hours: (L-T-P): **0- 0 - 4**	Course Credits: **02**
Formative Assessment Marks: **20**	Duration of ESA/Exam: **4 Hrs.**
Summative Assessment Marks: **30**	

Course Outcomes (CO's):

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

1. Identify microbiological techniques, the defining characteristics of the major groups of microorganisms and apply to study microbial phylogeny.
2. Classify the methods to measure microbial growth.
3. Evaluate how microorganisms interact with the environment in beneficial or detrimental ways.
4. Apply the scientific method by stating a question; researching the topic; determining appropriate tests; performing tests; collecting, analyzing, and presenting data and effectively communicate with both specialist and non-specialist audiences/community.

DSC4P3: Microbiology Lab

Experiment's
1. Study of aseptic techniques in Microbiology.
2. Study of apparatus and instrumentations use in microbiology experiments.
3. Microbial culture media and their preparation of various microorganisms.
4. Isolation and Identification of microbes from soil and water samples by Serial dilution method plating method.
5. Study of growth of a microorganism and growth curve.
6. Study of colony characters of bacteria.
7. Microbial staining techniques (simple and differential staining, cell wall, endospores, intracellular lipids, acid-fast, flagella, viability)
8. Slants and stab culture. Storage of microorganisms
9. Microbial motility tests by Hanging Drop method

10. Study of Fungi: *Aspergillus, Fusarium, Pencillum* and *Candida*

References:

1. Handbook of Microbiological Media by Atlas R.L.
2. Manual of Clinical Microbiology by Lennettee E.H.
3. Manual of Clinical Microbiology by Murray PR.
4. A Laboratory manual of Microbiology: Microbes in action.

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: 09/10/24 Course Coordinator Subject Committee Chairperson

Dept Name: Biotechnology
Semester-II
DSC5: Immunology and Immunodiagnostic

Course Title: **Immunology and Immunodiagnostic**	Course code: **24BTH2C5L**
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. Illustrate various types of immune response
2. Outline, compare and contrast the key mechanisms and cellular players of innate and adaptive immunity and how they relate
3. Elucidated the genetic basis for immunological diversity and the generation of adaptive immune responses
4. Gather information on research activities in the field of immunology and their applications.
5. Apply their knowledge and design immunological experiments to demonstrate innate, humoral or cytotoxic T lymphocyte responses and figure out kind of immune responses in the setting of infection (viral or bacterial).
6. Understand and explain the basis of immunological tolerance, autoimmunity and transplantation, basis of allergy and allergic diseases

DSC5: Immunology and Immunodiagnostic

Unit	Description	Hours
1	**Basics of immunology:** Immunity - Types of Immunity, Innate and Acquired Immunity. Cells of the Immune System - B & T Lymphocytes; T-cell subsets; Antigen Presenting Cells. Organs of the immune System: Primary lymphoid organs (Bone marrow and Thymus); Secondary lymphoid organs (lymph nodes, spleen and mucosal-associated lymphoid tissue). Antigens - Immunogenicity versus Antigenicity, Factors that influence immunogenicity, Epitopes - Properties of B-cell epitopes and T-cell epitopes, Haptens and the study of Antigenicity.	**11**

2	**Humoral Immunity**: Immunoglobulins; structure, classes and distribution of antibodies. Theories of antibody formation. Antibody diversity: models, organization of Ig genes, mechanism of gene rearrangement, generation of diversity; expression, synthesis and class switching, antibody engineering. Principles of cell signaling; Kinetics of immune response, memory; B cell maturation, activation and differentiation; T-cell maturation, activation and differentiation and T-cell receptors. B cell activation, proliferation and differentiation. Generation of humoral immune response- primary and secondary. Complement system – alternate and classical pathways, initiators and MAC.	**11**
3	**Cell mediated immunity:** Major histocompatibility complex and antigen presentation: MHC- organization, inheritance, genes, molecules and peptide binding, expression, disease susceptibility, immune responsiveness, self MHC restriction, cytosolic and endocytic pathway for antigen processing. T-cell receptor, T-cell maturation, activation and differentiation: TCR- genetic organization and rearrangement of genes, TCR-complex, peptide binding, thymic selection, activation and differentiation of T cells. Generation, activation and differentiation of B cells: B cell maturation, activation and proliferation, germinal centers, regulation of the responses. Cell mediated cytotoxicity: Effector T cells, cytotoxic T cells, NK cells, ADCC	**11**
4	**Clinical immunology:** Immunity to Infection: Bacteria, viral, fungal and parasitic infections (with examples from each group); Hypersensitivity - Type I-IV; Autoimmunity; Types of autoimmune diseases; Mechanism and role of CD4+ T cells; MHC and TCR in autoimmunity; Treatment of autoimmune diseases; Tumor immunology - Tumor antigens; Immune response to tumors and tumor evasion of the immune system, Cancer immunotherapy; Immunodeficiency - Primary immunodeficiencies, Acquired or secondary immunodeficiencies.	**11**
5	**Immunodiagnostic techniques** Precipitation, agglutination and complement mediated immune reactions; Production of polyclonal and monoclonal antibodies: Principles, Techniques and applications; Advanced immunological techniques - RIA, ELISA, Western blotting, ELISPOT assay, Immunofluorescence, Flow cytometry and Immunoelectron Microscopy; Surface plasmon resonance, Biosensor assays for assessing ligand - receptor interaction, CMI techniques-lymphoproliferation assay, Mixed lymphocyte reaction, Cell Cytotoxicity assays, Apoptosis.	**11**

References:

1. Kuby Immunology (2018) 8th ed., Punt J, Stranford S, Jones P and Owen JA, W.H Freeman and Company, ISBN: 978-1319114701.
2. Janeway's Immunobiology (2017) 9th ed., Murphy KM and Beaver C, WW Norton and Company, ISBN: 978-0815345510.
3. Roitt's Essential Immunology (2017) 13th ed., Delvis PJ, Martin SJ, Burton DR and Roitt, IM, Wiley-Blackwell, ISBN: 978-1118415771.14
4. Lippincott's illustrated Reviews Immunology (2012) 2nd ed., Doan T, Melvold R, Viselli S and Waltenbaugh, C, Wolters Kluwer India Pvt, Ltd, ISBN: 978-8184737639.
5. Roitt, I.M, 2006. Essential of Immunology 12th edition, ELBS, Blackwell Scientific Publication
6. Abul K. Abbas, Andrew H.L, Shiv Pillai, "Cellular and Molecular Immunology" 7/e Saunders Publications
7. The Immune system– peter Parham Garland science, 2/e, 2001
8. Chakravarty, A. K. (2024). Immunology and Immunotechnology. Oxford University Press.
9. Ghosh, S. (2024). Immunology & Immunotechnology. Books & Allied Pvt. Ltd.
10. Annadurai, B. (2024). A Textbook of Immunology and Immunotechnology. S. Chand Publishing.

Date: 09/10/24 Course Coordinator Subject Committee Chairperson

Dept Name: Biotechnology
Semester-II
DSC6: Genomics and Genetic engineering

Course Title: **Genomics and Genetic engineering**	Course code: **24BTH2C6L**
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. Explain the detailed characteristics of prokaryotes and eukaryotes genome as well as application of forward and reverse genetics.
2. Apply structural and functional genomics approaches on newly sequenced genome for functional characterization of genes.
3. Apply cloning and transformation techniques in prokaryotic and eukaryotic systems
4. Evaluate selectivity and specificity of vectors for cloning genes and their expressions
5. Apply rDNA techniques in development of genetically modified organisms for medical applications.

DSC6: Genomics and Genetic engineering

Unit	Description	Hours
1	**Origin of genomics:** The first DNA genomes, Structure and organization of prokaryotic and eukaryotic genomes – nuclear, mitochondrial and chloroplast genomes, Microbial genomes (including yeast), Plant genomes (Arabidopsis and rice), Animal genomes (fruit fly, mouse, human), Genomes and human evolution, The concept of minimal genome. Genetic maps, Physical maps, EST and transcript maps, Functional maps and Functional genomics, Human genome project-landmarks on chromosomes generated by various mapping method, Comparative genomics and collinearity/synteny in maps, Genetic variation polymorphism, deleterious mutation; FISH to identify chromosome landmarks. Genomics in medical practice, personalized	**11**

	medicine, use of SNP in pharmacogenomics, DNA Microarray technology: Basic principles and design, Global gene expression analysis, Comparative transcriptomics, Differential gene expression.	
2	**Introduction to Recombinant DNA technology:** Enzymes used in Recombinant DNA technology (Restriction endonucleases, DNA modifying enzymes, other nucleases, Polymerases, Ligase, kinases and phosphatases), Isolation and purification of DNA (genomic and plasmid) and RNA. Maxam Gilbert and Sanger Sequencing methods, Molecular cloning of DNA or RNA fragments in bacterial and eukaryotic systems; linkers, adaptors, and homopolymers.	**11**
3	**Vectors in gene cloning:** Expression cassette: Promoters (Constitutive, Inducible, Tissue specific), Terminators, Reporters, Markers (Antibiotic resistant, Herbicide resistant, Antimetabolite); Vectors in gene cloning - Plasmids (pBR322, pUC), Bacteriophages (phage l, M13), Cosmids, Phagemids, Yeast plasmid vector, Viral vectors (Adenovirus, Adeno-associated virus, Baculo virus, Herpes virus, Retrovirus, Cauliflower mosaic virus, Tobacco mosaic virus, Potato virus X), Transposons (Ac-Ds, P) Artificial chromosome (BAC, YAC, HAC), Shuttle vector, Expression vector.	**11**
4	**Gene transfer, Screening & Selection methods**: Transformation - Physical method (electroporation, micro-injection, particle bombardment, liposome mediated transfer); Chemical method (PEG mediated, DEAE Dextran mediated, CaPO4 mediated gene transfer); Biological method (Agrobacterium mediated gene transfer). Insertional inactivation, Blue-White selection, Colony - in situ hybridization, In vitro selection, In vitro translation, Radioactive antibody test, Immunological techniques, DNA labelling, dot blot hybridization, Molecular beacons. Gene Silencing, RNA interference, antisense therapy, Gene Knockout. Blotting techniques - Southern, Northern, Western and South-Western.	**11**
5	**Molecular Techniques:** RFLP, RAPD, AFLP, DNA Finger printing, Polymerase chain reaction (PCR) and types of PCR, DNA Foot printing, Microarray (DNA & Non-DNA). Libraries - Genomic library; C-DNA library & its types; BAC library; YAC library; Methyl filtration libraries; COT fractionation-based libraries. Bioethics & Biosafety in genetic engineering; IPR & Patenting.	**11**

References:

1. Principles of Gene Manipulation and Genomics (2016) 8th ed., Primrose, SB and Twyman, R, Wiley

Blackwell, ISBN: 978-1405156660.

2. Gene Cloning and DNA Analysis: An Introduction (2019) 7th ed., Brown, TA, Wiley Blackwell, ISBN: 978-1119072560.
3. Genome 4 (2017) 4th Brown, TA, Garland science, ISBN 13: 978-0815345084.
4. J. Sambrook, E. Frisch and T. Maniatis 2000. Molecular Cloning: Laboratory manual , Cold Spring Harbor Laboratory Press New York.
5. D.M. Glover and BD Hames 2001. DNA Cloning: A Practical Approach, IRL Press, New York.
6. Introduction to Genomics (2015) 2nd ed., Lesk, AM, Oxford university Press India, ISBN: 978-0198745891.
7. Genomics and Personalized Medicine: What Everyone needs to Know (2016) 1st ed., Snyder, M, OUP-USA, ISBN: 978-0190234768.
8. Doudna, J. A., & Sternberg, S. H. (2024). A Crack in Creation: Gene Editing and the Unthinkable Power to Control Evolution. Houghton Mifflin Harcourt.
9. Collins, F. S., & Venter, J. C. (2024). The Language of Life: DNA and the Revolution in Personalized Medicine. HarperCollins.
10. Church, G., & Regis, E. (2024). Regenesis: How Synthetic Biology Will Reinvent Nature and Ourselves. Basic Books.
11. Mukherjee, S. (2024). The Gene: An Intimate History. Scribner.
12. Shapiro, B. (2024). How to Clone a Mammoth: The Science of De-Extinction. Princeton University Press.
13. Korf, B. R., & Irons, M. B. (2024). Human Genetics and Genomics (5th ed.). Wiley.
14. Kline, A. D., & Smith, J. (2023). Genomics in the Clinic: A Practical Guide to Genetic Testing, Evaluation, and Counseling. Springer.
15. Mrode, R. A., & Thompson, R. (2023). Linear Models for the Prediction of the Genetic Merit of Animals. CRC Press.
16. Watson, J. D., & Baker, T. A. (2024). Molecular Biology of the Gene (7th ed.). Pearson.
17. Brown, T. A. (2024). Genomes 4. Garland Science.

Date: 09/10/24 Course Coordinator Subject Committee Chairperson

.

Dept Name: Biotechnology
Semester-II
DSC7: Bioprocess engineering and Technology

Course Title: **Bioprocess engineering and Technology**	Course code: **24BTH2C7L**
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. Appreciate relevance of microorganisms from industrial context and can carry out stoichiometric calculations and specify models of their growth
2. Design and operate various fermenters
3. Calculate yield and production rates in a biological production process, and also interpret data
4. Calculate the need for oxygen and oxygen transfer and can also critically analyse any bioprocess from market point of view
5. Give an account of important microbial/enzymatic industrial processes in food and fuel industry

DSC7: Bioprocess engineering and Technology

Unit	Description	Hours
1	**Bioprocessing Fundamentals:** Biotechnology and Bio-process engineering-Historical development of bioprocess technology-Difference in approaches by biologist and engineer-Introduction to Bioproducts-Bioprocess principles and operations- Outline of a bioprocess and the various unit operations involved in bioprocesses. Steps in bioprocess development- General material balance equation for steady state (for manufacture of penicillin and ethanol)-Generalized bioprocess flow sheets: example of penicillin/Bacitracin/ethanol. Bio-process regulatory constraints.	**11**
2	**Microbial growth and product formulation**	**11**

	Quantification of cell concentration, Phases of cell growth in bath culture, growth associated and non-growth associated product formation kinetics, environmental factors affecting growth kinetics. Heat generation by microbial growth. Structured and unstructured models for microbial growth- Substrate limited growth-models with growth inhibitors- growth model for filamentous organisms. Microbial interaction in mixed cultures: Major classes of microbial interactions, microbial participation in the natural cycles of matter, Industrial utilization of mixed cultures in biological wastewater treatment.	
3	**Fermentation Principles** Fermentation Process-General requirements of fermentation Process; An overview of aerobic and anaerobic fermentation process and their application in industry. Media Design: Medium requirements for fermentation process-examples of simple and complex media; Design and usage of commercial media for industrial fermentations, Sterilization: Batch and continuous heat sterilization-sterilization of Liquid media, Filter sterilization of liquids. Thermal death kinetics. Elements in bioreactor design- overview of bioreactor, Construction materials, types of bioreactors, its developments using microbial processes, mammalian cell culture, and plant cell culture, components of bioreactors and importance.	**11**
4	**Bioreactor Design** Different types of bioreactors: Batch, fed-batch and chemostat with recycle, multistage chemostat and perfusion systems, immobilized cell systems. Solid state and submerged state fermentation. Imperfectly mixed bioreactor system. Specialized bioreactors: Tubular bioreactors, Membrane bioreactors, Tower bioreactor, Fluidized bioreactor, Packed bed bioreactors, Photo-bioreactors etc. Operation and control of bioreactor system: pH, Temperature, Aeration and agitation systems, Impeller design, control of other parameters. Non-mechanically agitated bioreactor systems. Data analysis.	**11**
5	**Downstream process** Separation of Biomass from culture fluid. Coagulation and flocculation. Disruption of microbial cells Separation of insoluble solids from fermentation broth: Centrifugation and sedimentation, filtration Cell processing using tangential flow filtration, Adsorption, Precipitation, Cell processing with hollow fiber membranes. Ultra-filtration process in Biotechnology. Liquid-liquid extraction of biopolymers, Aqueous two-phase extraction, Supercritical fluid extraction. Different Chromatographic techniques: Ion exchange recovery of antibiotics, Ion exchange recovery of proteins, Gas Chromatography, Size exclusion chromatography, Hydrophobic chromatography, High performance liquid chromatography.	**11**

	Electrophoresis. Dialysis and electro dialysis. Recovery of Biological products by distillation. Crystallization. Drying.	

References:

1. Pauline M Doran (2013) Bioprocess Engineering Principles, 2nd Edition, Academic Press, USA.
2. Michael L Shuler & Fikret Kargi. (2008) Bioprocess Engineering: Basic Concepts., 2nd Edition, Prentice Hall of India, New Delhi.
3. Elmar Heinzle, Arno P. Biwer, Charles L. Cooney. (2006) Development of Sustainable Bioprocesses Modeling and Assessment, John Wiley & Sons Ltd.
4. Tapobrata Panda. (2011) Bioreactors: Analysis and Design, 1st Edition, Tata McGraw Hill Education Private Limited, New Delhi.
5. Douglas S. Clark, Harvey W. Blanch. (1995) Biochemical Engineering, 2nd Edition, CRC Press.
6. Bioprocess Engineering: Basic Concepts (2017) 3rd ed. Shuler, ML, and Kargi, F. Pearson Prentice Hall, ISBN: 0137062702.
7. Principles of Fermentation Technology (2016) 3rd ed. Stanbury P, Allan Whitaker, Stephen Hall. Imprint (Butterworth-Heinemann), ISBN: 9780080999531.
8. Biochemical Engineering Fundamentals (2013) 5th reprint J. E. Bailey and Ollis, D. F. McGraw-Hill Education (India) Pvt Ltd., ISBN: 0070701237.
9. Bioprocess Engineering Principles (2013) 2nd ed. Doran, P.M, Academic Press, ISBN: 978-0-12-220851-5.
10. Bioreactors Analysis and Design (2011) Panda T, Tata McGraw Hill, ISBN: 978-0-07-070424-4.
11. Casida, L,E,, Jr. (1997). Industrial Microbiology. New AI. New Delhi.
12. Lee, J. M., & Papoutsakis, E. T. (2024). Bioprocess Engineering: Principles and Applications. Wiley.
13. Shuler, M. L., & Kargi, F. (2024). Bioprocess Engineering: Basic Concepts. Prentice Hall.
14. Doran, P. M. (2024). Bioprocess Engineering Principles. Academic Press.
15. Nielsen, J., & Villadsen, J. (2024). Bioreaction Engineering Principles. Springer.
16. Bailey, J. E., & Ollis, D. F. (2024). Biochemical Engineering Fundamentals. McGraw-Hill.
17. Stanbury, P. F., Whitaker, A., & Hall, S. J. (2024). Principles of Fermentation Technology (3rd ed.). Butterworth-Heinemann.
18. Mitchell, D. A., Krieger, N., & Berovic, M. (2024). Solid-State Fermentation: Bioreactors, Fundamentals and Applications. Springer.
19. El-Mansi, E. M. T., Bryce, C. F. A., Demain, A. L., & Allman, A. R. (2024). Fermentation Microbiology and Biotechnology (4th ed.). CRC Press.
20. Wang, D. I. C., Cooney, C. L., Demain, A. L., Dunnill, P., Humphrey, A. E., & Lilly, M. D. (2024). Fermentation and Biochemical Engineering Handbook: Principles, Process Design, and Equipment (3rd ed.). William Andrew.
21. McNeil, B., & Harvey, L. M. (2024). Practical Fermentation Technology. Wiley.

Date: 09/10/24 Course Coordinator Subject Committee Chairperson

Dept Name: Biotechnology
Semester-II
DSC8: Stem cell technology and regenerative medicine

Course Title: **Stem cell technology and regenerative medicine**	Course code: **24BTH2C8L**
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. Asses the benefit of hemopoietic stem cells in the treatment of cancer and other diseases
2. Apply encapsulation technology and stem cells for therapeutics and Regenerative medicine
3. Utilize the molecular techniques for diagnosis of Biochemical, Immune, Genetic and Neurological disorders

DSC8: Stem cell technology and regenerative medicine

Unit	Description	Hours
1	**Introduction to stem cell:** Stem cell – Definition, characterization, Pluripotent stem cells, Self-renewal and differentiation, hierarchy, Stem cell niche, types of stem cell niches: Embryonic stem cell niches and Hematopoietic stem cell niche. Tissue specific types of stem cells: Peri- and post-natal Mesenchymal stromal cells, Hematopoietic stem cells, Neural stem cells, Cardiac stem cells, Hepatic stem cells	**11**
2	**Cell signals and its pathways:** Characteristics of stem cell – cell cycle, Ras/ Raf pathways, P13K cell signaling, p53 check points, Role of LIF pathways in cell cycle control. Stem cell communications – Types of Junctional complexes- Tight, Gap, Adherens, Extracellular matrix ECM regulated signaling,	**11**

	Signaling in stem cells niches, Dysregulation of stem cell niches.	
3	**Haemopoietic Stem Cells and Cloning:** Hematopoietic stem cells differentiation, trans-differentiation and growth factors. Classification and manifestations of Hemopoietic stem cell disorders, aplastic Hemopoietic stem cell disorders, clinical applications of colony stems, complications of germ therapy, replacement therapy and bone marrow transplantation, immunological principles**,** preservation and clinical use of blood and blood components. Induced Pluripotent stem cells (iPS), germ line stem cells; Recruiting Donors and Banking hES cells; IPRs and hES Cells. Fate mapping of stem cells in experimental systems. Genetically engineered stem cells and experimental therapies.	**11**
4	**Regenerative medicine:** Stem cell-based therapies: stem cells and repair of heart and nervous system; regeneration strategies. Skin replacement, brain cell transplantation and stem cells in aging. Encapsulation technology and therapeutics- Diabetes, Hypothyroidism, Hemophilia Bioartificial organs, Stem cell therapy - Embryonic and adult Stem Cells, Totipotent, Pluripotent and Multipotent Cells. Bone marrow transplantation versus Stem cell transplantation and GVHD.	**11**
5	**Downstream process:** Societal implications: women, low-income, Different religious views, Current Ethical Guidelines in India, Ethical views of other countries and how this affects advancement of science Policy. Current Regulation of Human Embryonic Stem Cell Research. Future of SC research	**11**

References:

1. Jonathan Slack, Stem cells- A Very Short Introduction, Oxford, 2012.
2. Stewart Sell 2003 (Ed) Stem Cells Handbook, Humana Press, NY
3. Verma IM and Gage FH 2002 (Ed) Regenerative Medicine, Natl Acad Sci & Engg, USA
4. The Natl Academies, USA 2007 Understanding Stem Cells
5. The Natl Academies, USA 2002 Stem Cells and the Future of Regenerative Medicine
6. Stem Cells Info 2008, NIH USA Terese
7. Winslow 2006 Regenerative Medicine, Natl Acad Sci & Engg, USA
8. Marshak et al., 2000 Stem Cell Biology, CSHL press, USA.
9. Regenerative Medicine (2006) NIH, Bethesda, USA.
10. Bernhard O. Palsson , Sangeeta N. Bhatia, Tissue Engineering, Prentice Hall; 1 edition, 2003

Date: 09/10/24 Course Coordinator Subject Committee Chairperson

Dept Name: Biotechnology
Semester-II
SEC2: Biopharmaceutical techniques

Course Title: **Biopharmaceutical techniques**	Course code: **24BTH2S2LP**
Total Contact Hours: (L-T-P): **1- 0 - 2**	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. Comprehend the development, characterization and evaluation of bio therapeutic proteins.
2. Explore the principles and applications of novel bio therapeutics.
3. Formulate protein-based drugs and study their physio-chemical and pharmacological properties.
4. Perform quality control tests to validate quality of product.
5. Apply the knowledge of formulation of biopharmaceuticals for extended release of therapeutics.

SEC2: Biopharmaceutical techniques

Unit	Description	Hours
1	**Drug development process of protein-based therapeutics:** Transforming New Molecular Entities into Drugs, Differences between Development of Biotechnology Products of Macromolecules and Chemical Products, Current Trends in Drug Development, Drug designing: Rational, combinatorial and High Throughput screening.	**07**
2	**Immuno-pharmacology and formulation of peptides:** Overview to immunopharmacology, Antibody-mediated response, Vaccines, Cell mediated immune response, Cancer immunotherapy, Immunosuppressant and immunostimulatory. Making Small Protein Particles, Lyophilization, Multiphase Drug Delivery Systems, Protein	**07**

	Compaction, Self- Emulsifying Drug Delivery Systems, skin and parental drug delivery system.	
3	**Practical's** Laboratory 1: Test for sterility: Bacteriological Test for Water for injection (WFI). Laboratory 2: Determination of minimum inhibitory concentration of given antibiotic. Laboratory 3: Standardization of given herbal formulation by TLC. Laboratory 4: Validation of Autoclave by biological indicator method. Laboratory 5: Handling and working of lyophilizer for freeze drying of protein formulation. Laboratory 6: Detection of HIV antibodies Tri- dot test. Laboratory 7: Determination of Partition coefficient of given formulation. Laboratory 8: Determination of antioxidant activity of given formulation by DPPH method Laboratory 9: Extraction and isolation of Caffeine from tea powder. Laboratory 10: Detection of antigen in the given sample by ELISA Laboratory 11: Preparation and evaluation of controlled release formulation. Laboratory 12: Preparation and characterization of blank / loaded liposome.	**28**

References:

1. Christine M. Bladon (2002) Pharmaceutical Chemistry, John Wiley & Sons, Ltd.
2. Manfred E. Wolff (2000) Burger's Medicinal Chemistry and Drug Discovery (5th edition) A Wiley & Sons, Inc.
3. Grietje Molema and Dirk KF. Meije (2002) Drug Targeting Organ-Specific Strategies r. Wiley-VCH.
4. Melgardt M. de Villiers (2007) Nanotechnology in Drug Delivery, Springer.
5. Rodney JY, Milo Gibaldi (2003) Biotechnology and Biopharmaceuticals transforming proteins and genes into drugs, A John Wiley & Sons, Inc., Publication.
6. Gavin Brooks (1998) Biotechnology in Healthcare, An introduction to biopharmaceuticals, Pharmaceutical Press (London).
7. Shayne cox gad (2007) Handbook of pharmaceutical Biotechnology A John Wiley & Sons, Inc., Publication
8. Grietje Molema and Dirk KF (2002) Drug Targeting Organ-Specific Strategies by Meijer. Wiley-VCH.
9. Gary Walsh (2003) Biopharmaceuticals Biochemistry and Biotechnology, Wiley.
10. Heinrich Klefenz. (2002) Industrial Pharmaceutical Biotechnology, Wiley-VCH.
11. Gary Walsh (2011) Biopharmaceuticals: Biochemistry and Biotechnology, Wiley-VCH.

Date: 09/10/24 Course Coordinator Subject Committee Chairperson

Dept Name: Biotechnology
Semester-II
DSC5P4: Immunology and immunodiagnostic lab

Course Title: **Immunology and immunodiagnostic lab**	Course code: **24BTH2C5P**
Total Contact Hours: (L-T-P): **0- 0 - 4**	Course Credits: **02**
Formative Assessment Marks: **20**	Duration of ESA/Exam: **4 Hrs.**
Summative Assessment Marks: **30**	

Course Outcomes (CO's):

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

1. Evaluate usefulness of immunology in different pharmaceutical companies
2. Identify proper research lab working in area of their own interests;
3. Apply their knowledge and design immunological experiments to demonstrate innate, humoral or cytotoxic T lymphocyte responses and figure out kind of immune responses in setting of infection (viral or bacterial) by looking at cytokine profile.

DSC5P4: Immunology and immunodiagnostic lab

Experiment's
1. Determination of A, B, O and Rh blood groups in human beings.
2. Staining of blood smear and identification of different leukocytes.
3. To perform the Technique of Radial immunodiffusion
4. To learn and perform the technique of Ouchterlony Double Diffusion Technique
5. To perform the pregnancy test with the help of Pregnancy Kit
6. To learn the technique of Immuno-electrophoresis
7. To study the technique of Rocket Immuno-electrophoresis for determination of concentration of antigen in unknown sample
8. To perform WIDAL test for detection of typhoid.
9. To study the different immune-informatics tools.
10. To perform the sandwich Dot ELISA Test for antigen detection
11. To perform Affinity chromatography for antibody purification.
12. To identify cells in a blood smear
13. To isolate monocytes from blood

14. To isolate peripheral blood mononuclear cells
15. Identification of t cells by T-cell rossetting using sheep RBC

References:

1. Wilson, K and Walker, J. Practical Biochemistry, Principles and Techniques. Cambridge University Press
2. Harlow, E.D. and Lane, D. Using Antibodies. A Laboratory Manual. CSH Laboratory Press. NY.
3. Hay, F.C., Westwood, O.M.R. Practical Immunology (4th Edition). Blackwell Publishing
4. Walker, J.M. (Editor). The protein protocols handbook. Humana press, NJ protocols in Immunology
5. Immunology: Theoretical and practical concepts in Laboratory Medicine. Hannah D. Zane, Saunders; 1 edition (2001).
6. Clinical Immunology and Serology: A Laboratory Perspective By Christine Dorresteyn Stevens, F.A. Davis Company; 2nd Revised edition edition (2009)

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: 09/10/24 Course Coordinator Subject Committee Chairperson

Dept Name: Biotechnology
Semester-II
DSC6P5: Genomics and genetic engineering lab

Course Title: **Genomics and genetic engineering lab**	Course code: **24BTH2C6P**
Total Contact Hours: (L-T-P): **0- 0 - 4**	Course Credits: **02**
Formative Assessment Marks: **20**	Duration of ESA/Exam: **4 Hrs.**
Summative Assessment Marks: **30**	

Course Outcomes (CO's):

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

1. Hands on and gain expertise in handling routine laboratory equipment used in Genomics lab
2. To use modern tools for analysis of Nucleic acids and their further analysis. Independently execute a laboratory experiment using the standard methods and techniques in molecular biology, with the appropriate analysis and interpretation of results obtained.
3. Exemplify different types of polymerase chain reactions and their applications.
4. Implement, organize and design different vectors for gene cloning and expression
5. Generating contextual and conditional knowledge of gene function for various applications

DSC5P4: Immunology and immunodiagnostic lab

Experiment's
1. Isolation of genomic DNA from bacteria
2. Preparation of plasmid from given bacterial sample and gel analysis.
3. Gel elution of DNA
4. PCR amplification of gene of interest and analysis by agarose gel electrophoresis
5. Restriction digestion of vector and insertion using Ligase.
6. Competent cell preparation for transformation
7. Transformation in E.*coli DH5α*.
8. Induction of protein with IPTG and analysis on SDS-PAGE
9. Purification of protein and analysis of purification by SDS-PAGE
10. Southern/Northern/Western blotting hybridization

11. Human gene, protein, variant nomenclature and databases
12. Various file formats (including .vcf), databases, process, tools and pipelines (open source) for clinical and personal genome/exome analysis, annotation, and interpretation for personalized diagnosis and therapy.
13. Polygenic risk score and its implementation in disease (cancers, diabetes, obesity, CVDs, diabetes), nutrition, fitness, sports, and other health and wellness traits, adverse drug reaction (PGx) prediction

References:

1. Michael R. Green, Joseph Sambrook, Molecular Cloning: A Laboratory Manual (Fourth Edition), 2014.
2. William Wu, Michael J. welshpeter B. KaufmanHelen H. Zhang, Methods in Gene Biotechnology, CRC Press, New York. 1997.
3. Bruce A. White, Methods in Molecular Biology, Chapman and Hall, London, New York.
4. Durbin, R., Eddy, S., Krog, A., and Mitchison, G. (2003). Biological Sequence Analysis, Probablistics Models. Cambridge Press.
5. Elmasri, R. and Navathe, S.B. Fundamentals of database system. Addison-Wesley.
6. Pevsner, J. (2003). Bioinformatics & Functional Genomics. John Wiley and Sons.
7. Mount, D. W.(2001). Bioinformatics Sequence and Genome Analysis. Cold Spring Harboor Laboratory Press, New York.

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: 09/10/24 Course Coordinator Subject Committee Chairperson

Dept Name: Biotechnology
Semester-II
DSC7P6: Bioprocess engineering and technology lab

Course Title: **Bioprocess engineering and technology lab**	Course code: **24BTH2C7P**
Total Contact Hours: (L-T-P): **0- 0 - 4**	Course Credits: **02**
Formative Assessment Marks: **20**	Duration of ESA/Exam: **4 Hrs.**
Summative Assessment Marks: **30**	

Course Outcomes (CO's):

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

1. Understand the growth kinetics, the role of various factors affecting the process of growth. They will also be able to define the media for submerged and solid-state fermentation process and sterilization
2. State the significance of application of process technology on enzyme production, enzyme kinetics, solve the mass balance of production process, learn the process of oxygen transfer rate, agitation systems
3. Collect the proficient knowledge of design of fermenter and operation of fermentation process, methods of translation of laboratory data to pilot scale process

DSC7P6: Bioprocess engineering and technology lab

Experiment's
1. Fermenter Design
2. Determination of doubling time and Z value for Sterilization of fermenter and media
3. Determination of oxygen transfer rate and volumetric oxygen mass transfer coefficient (KLa) under variety of operating conditions in shake flask and bioreactor.
4. Isolation of Different industrially important strains (*Saccharomyces cerevisiae, Lactobacillus, Aspergillus, Bacillus spp*.)
5. Strain improvement by applying mutagenic agents
6. Preparation of fermentation pre-culture
7. Study of antibiotic producing microorganism of local soil: a) Isolation, b) Screening
8. Production of antibiotics by *Penicillium spp*
9. Production of ethanol and organic acids.
10. Production of single cell protein: a) Yeast cells, b). *Spirilluna* and others
11. Enzyme production: extra and intracellular enzymes (amylase, Cellulase, Sucrase, Pectinase,

Lipases, Protease, Alkaline and Acid Phosphatase, alcohol dehydrogenase) by microorganisms and other sources.

12. Production of vitamins.
13. Purification, a) precipitation, b) dialysis, c) column chromatography, d) extraction
14. Various immobilization techniques of cells/enzymes, use of alginate for cell immobilization

References:

1. Stanbury RF and Whitaker A., Principles of Fermentation Technology, Pergamon press, Oxford, 1997. ISBN: 0080361323
2. Booth, C. (Ed) (1974). Methods in Microbiology. Vol. IV Academic Press.
3. Bull, A.T. and Dalton, H. (Eds.) (1995). Comprehensive Biotechnology. Pergamon Press, Oxford
4. Butterworth-Heinemann (1992). Product Recovery in Bioprocess Technology, Elviser.
5. Casida, L, E,, Jr. (1997). Industrial Microbiology. New AI. New Delhi
6. Doran, P.M. (1995). Bioprocess Engineering Principles. Academic Press.
7. Dordrick, J.S. (1991). Biocatalyst for industry. Plenum Press, New York.
8. El-Mansi, E.M.T. and Bryce, C.F.A. (2002). Fermentation Microbiology and Biotechnology. T & F, London
9. Gerhartz, W. (1990). Enzymes in Industry: Production and applications. VCH Publishers, New York Gupta, P, K. (1999). Elements of biotechnology. Rastogi Publication.
10. Helmut Uhling (1998). Enzyme technology. John Wiley.
11. Lodish, L., Baltimore, D., Berk, A., Zipursky, S.L., Matsudaira, P., Darnell, J. (2000). Molecular cell biology.
12. Malla, R. (2011) Bio-Molecules in Microorganisms and Their Roles to Friendly Environment.
13. Michael L Sular and FikretKargi (2002): Bioprocess Engineering, Basic concepts, Prentice Hall.
14. WHF and Company. McNeil, B., and Harvey, L.M. (1990). Fermentation a practical approach. IRL press. NY.

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: 09/10/24 Course Coordinator Subject Committee Chairperson

Dept Name: Biotechnology
Semester-III
DSC9: Biostatistics and Bioinformatics

Course Title: **Biostatistics and Bioinformatics**	Course code: **24BTH3C9L**
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 importance of various databases.
2. Understand various dimension of bioinformatics.
3. Analyze the various databases available for protein and nucleic acids.
4. Learn sequence analysis and to compare between species and individuals

DSC9: Biostatistics and Bioinformatics

Unit	Description	Hours
1	**Biostatistics:** Basics and uses of Measures of Central values (Mean, Median, Mode), Measures of Dispersion (Standard Deviation and coefficient of variation) in data analysis and presentation. Basic theoretical knowledge of Correlation and Probability - Sample Testing: Large samples (Z), small sample test: t, Chi-square, ANOVA, Comparison of means in one or two groups (student's t-test). Principles of test of significance: One-Tailed Versus Two-Tailed Tests, p-Values, Type I and Type II Errors, The Power Function, Comparison of means in three or more groups (ANOVA), F-test.	**11**
2	**Presentation of variation by figures**: data representation: Histogram, Stem-&-Leaf Plot, Line Diagram, Frequency Polygon, Frequency Curve, Pie Diagram, Bar Diagrams, Scatter Diagram, Box-&-Whisker Plot, Bubble Plot, Growth chart, Dendrogram, Nomogram, Partogram, Pedigree Chart, Cartogram. Confidence Intervals: Confidence Intervals, Confidence Intervals for a Single Population Mean, Z and t Statistics for Two Independent Samples. Experimental Design: Principles: Randomization, Replication, Local control, Size and shape of the plot.	**11**
3	**Computer application in biology:** bioinformatics and its applications. Web browsing. Information networks, nucleic acid databases: Genbank, NCBI, EMBL, DDBJ; structure of Genbank entries. Primary protein databases: PIR, SWISSPROT, TrEMBL; Secondary protein	**11**

	databases - PROSITE, PROFILES, PRINTS, Pfam; Structural classification databases - SCOP, CATH; Literature databases - PubMed, Medline; Bibliographic databases - OMIM, PubMed.	
4	**Sequence Annotation:** Principles and tools; Sequence retrieval system Entrez, SRS; Sequence submission tool - BANKIT, SEQUIN, WEBIN, SAKURA. Molecular phylogeny - Concepts of tree - rooted and unrooted trees; Molecular Clocks, Clustering and Phenetic method, Cladistic method; Steps in constructing phylogenetic analysis; Bootstrapping strategies. Molecular viewers - Rasmol, Chime and Spdb viewer	**11**
5	**Sequence alignment**: concepts in alignment, Local & Global; Pairwise & Multiple; Tools for sequence alignment - BLAST, FASTA, Clustal W; Substitution matrices; Scoring matrices - PAM & BLOSUM; Dot plot; EST Clustering and analyses, Computational methods of gene prediction.	**11**

References:

1. Introduction to Biostatistics and Research Methods by Sunder Rao and J Richards
2. Medical Statistics by David Machin, Michael J Campbell and Stephen J Walters, John Wiley and Sons.
3. Statistical Methods, S.P. Gupta
4. Fundamentals of mathematical statistics. S.C. Gupta &Kapoor
5. Statistical methods in biological and Health Science, J.S. Milton & J.O. Tsokan
6. David W Mount. 2001. Bioinformatics Sequence and Genome analysis. Cold Spring harbor laboratory
7. David W Mount. 2004. Bioinformatics: sequence and Genome Analysis (Ed:2). Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York.
8. Primrose SB. Principles of Genome Analysis, A guide mapping and sequencing DNA from different organisms. 2nd/Edn. 1998. Blackwell Science, Oxford ISBN 0-632-04983-9.
9. Rastogi, S.C., Menderatta, M. and Rastogi, P. 2004. Bioinformatics - concepts, skills and applications. CBS Publishers & Distributors, New Delhi.
10. Arthur M Lesk. 2002. Introduction to Bioinformatics. Oxford university press. New York.
11. Motulsky, H. (2024). Intuitive Biostatistics (4th ed.). Oxford University Press.
12. Pagano, M., & Gauvreau, K. (2024). Principles of Biostatistics (3rd ed.). CRC Press.
13. Sullivan, L. M. (2024). Essentials of Biostatistics in Public Health (4th ed.). Jones & Bartlett Learning.
14. Low, L. W. Y., & Tan, S. H. (2023). Practical Bioinformatics for Beginners: From Raw Sequence Analysis to Machine Learning Applications. Springer.
15. Jones, N. C., & Pevzner, P. A. (2023). An Introduction to Bioinformatics Algorithms (2nd ed.). MIT

Press.
16. Choudhuri, S. (2024). Bioinformatics for Beginners: Genes, Genomes, Molecular Evolution, Databases and Analytical Tools. Academic Press.

Date: 09/10/24 Course Coordinator Subject Committee Chairperson

Dept Name: Biotechnology

Semester-III
DSC10: Medical Biotechnology and Diagnostics

Course Title: **Medical Biotechnology and Diagnostics**	Course code: **24BTH3C10L**
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. Apply the concepts of medical biotechnology in disease diagnosis, prevention and treatment.
2. Asses the benefit of hemopoietic stem cells in the treatment of cancer and other diseases.
3. Apply encapsulation technology and stem cells for therapeutics, Regenerative and Nanomedicine.
4. Utilize the molecular techniques for diagnosis of Biochemical, Immune, Genetic and Neurological disorders.
5. Apply gene therapies, molecular and rDNA techniques for treatment of various diseases.

DSC10: Medical Biotechnology and Diagnostics

Unit	Description	Hours
1	**Introduction scope and applications in Medial Biotechnology:** Disease: bacterial, viral, fungal and parasitic. Investigation of epidemics. Methods of culturing and assaying: bacterial, viral and parasitic. Viral vaccines: conventional: killed/attenuated; DNA; peptide; recombinant proteins. Future development and scope of vaccines.	**11**
2	**Hemopoietic Stem Cells:** Hematopoietic stem cells differentiation, trans differentiation and growth factors. Classification and manifestations of Hemopoietic stem cell disorders, aplastic Hemopoietic stem cell disorders, clinical applications of colony stems, complications of germ therapy, replacement therapy and bone marrow transplantation, immunological principles, preservation and clinical use of blood and blood components.	**11**
3	**Regenerative and nanomedicine:** Encapsulation technology and therapeutics- Diabetes, Hypothyroidism, Hemophilia Bioartificial organs, Stem cell therapy - Embryonic and adult Stem Cells, Totipotent, Pluripotent and Multipotent Cells. Nanomedicine – Nanoparticles, Nanodevices- medical	**11**

	microrobotics, nanorobotics, Microbiovers, Nanomedicine.	
4	**Molecular Diagnostics:** Molecular techniques for analysis of these disorders; Biochemical disorders; Immune, Genetic and Neurological disorders; Assays for the Diagnosis of inherited diseases; Antibody based diagnosis; Monoclonal antibodies as diagnostic reagents; Production of monoclonal antibodies with potential for diagnosis	**11**
5	**Gene and molecular therapeutics:** General introduction, potential target diseases for gene therapy, gene transfer methods, and their applications, clinical studies, pharmaceutical production and regulation. Liposome and nanoparticles mediated gene delivery. Antisense technology, Clinical applications of recombinant technology; Erythropoietin; Insulin analogs and its role in diabetes; Recombinant human growth hormone.	**11**

References:

1. Daan Crommelin, Robert D Sindelar and Bernd Meibohm (2007). Pharmaceutical Biotechnology and Fundamental Applications, 2nd edition. Informa Health care USA, Inc.
2. Willam Irving, Time Boswell and Dlawar Ala'Aldeen (2006) BIOS Instant notes in Medical Microbiology. BIOS Scientific Publication.
3. Sambamurthy K and Ashutosh Kar (2006) Textbook of Pharmaceutical Biotechnology, Paperback 1st edn. New Age International.
4. Judit Pongracz and Mary Keen (2009) Medical Biotechnology, Churchill Livingstone publication.
5. Albert Sasson (2006) Medical Biotechnology, Brookings Institution Press.
6. Bernhard O Palsson and Sangeeta N Bhatia (2003) Tissue Engineering, Pearson Prentice Hall.
7. Pamela Greenwell, Michelle McCulley. (2007) Molecular Therapeutics: 21st century medicine, 1st Edition.
8. Lela Buchingham and Maribeth L Flawsm. (2007) Molecular Diagnostics: Fundamentals, Methods and Clinical Applications, 1st Edition, F A Davis Company, Philadelphia, USA.
9. Singh, J., Vyas, A., Wang, S., & Prasad, R. (2024). Microbial Biotechnology: Basic Research and Applications. Springer.
10. Madigan, M. T., Martinko, J. M., Bender, K. S., Buckley, D. H., & Stahl, D. A. (2024). Brock Biology of Microorganisms (15th ed.). Pearson.
11. Tortora, G. J., Funke, B. R., & Case, C. L. (2024). Microbiology: An Introduction (14th ed.). Pearson.
12. Gladwin, M., Trattler, B., & Mahan, C. S. (2024). Clinical Microbiology Made Ridiculously Simple (7th ed.). MedMaster.

13. Singh, A., & Verma, A. S. (2024). Microbial Biotechnology: Fundamentals and Applications. Academic Press

Date: 09/10/24 Course Coordinator Subject Committee Chairperson

Dept Name: Biotechnology

Semester-III
DSE1: A. Pharmaceutical Biotechnology and drug designing

Course Title: **Pharmaceutical Biotechnology and drug designing**	Course code: **24BTH3E1AL**
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 roles of biomolecules in the treatment of diseases
2. Develop new drug and vaccine products
3. Understand role of genomic information in development and treatment of diseases

DSE1: A. Pharmaceutical Biotechnology and drug designing

Unit	Description	Hours
1	**Biotechnology in pharmaceutical perspective:** Biology in drug discovery; Traditional drug discovery vs. rational drug discovery, rational drug discovery pipeline, concept of target-based drug design and target discovery, role of plant biotechnology in edible vaccine development. Definition: Generics and its advantages; Biogenerics and Biosimilars; Why biosimilars are not (bio) generics; The advent of Biosimilars; Protein-based biopharmaceuticals; Manufacturing processes; Global market; International Non-proprietary Names (INN) nomenclature system biosimilars regulation (EU position, US pathways, Government initiatives).	**12**
2	**Biotechnology in pharmaceutical industry:** Major areas for biotechnology in the pharmaceutical industry such as antibiotics, vaccines, diagnostics, antibodies, biopharmaceuticals (insulin, interferon, GSF, CSF & therapeutic proteins etc.); Commercial aspects, priorities for future biotechnological research.	**11**
3	**Industrial enzymes in drug development:** Penicillin amidase, lipase, oxidoreductase, nitrilase, protease etc. Use of all these enzymes for enantioselective synthesis of pharmaceutically important drugs / drug intermediates, future directions.	**10**
4	**Approved follow-on proteins/Biosimilars:** Characteristics of high-selling peptides and proteins, Products with expired patents; Challenging originator's patents; Target products for FOB (follow-on biologicals)/	**11**

	Biosimilars development peptides; Recombinant non-glycosylated proteins; Recombinant glycosylated proteins; Industries dealing with biogenerics and its market value; World scenario; Indian scenario.	
5	**Genomics in target discovery:** Concept of genome, genes and gene expression, genome sequencing and sequence comparison methods (e.g. BLAST), gene expression comparison methods (microarray). Comparative genomics and expression genomics for target discovery of communicable diseases and lifestyle disease.	**11**

References:

1. Pharmaceutical Biotechnology (2016) Helmer E, Syrawood Publishing House, ISBN: 978-1682861066.
2. Pharmaceutical Biotechnology (2014) Sreenivasulu V, Jayaveera KN and Adinarayana K, S Chand & Company, ISBN: 978-8121942478.
3. Pharmaceutical Biotechnology Fundamentals and Application (2013) Kokare C, Nirali Prakashan, Educational Publishers, ISBN: 978-8185790688.
4. Pharmaceutical Biotechnology: Concepts and Applications (2011) Walsh G, Wiley India Pvt Ltd, ISBN: 978-8126530250.
5. Pharmaceutical Biotechnology (2002) 2nd ed. Cromelin DJA and Sindelar RD, Taylor and Francis Group, ISBN: 978-3-527-65125-2.

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Dept Name: Biotechnology
Semester-III

DSE1: B. Microbial Biotechnology

Course Title: **Microbial Biotechnology**	Course code: **24BTH3E1BL**
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 deeper understanding of the microbial technology and its applications.

DSE1: B. Microbial Biotechnology

Unit	Description	Hours
1	**Introduction to microbial technology:** Microbial technology in human welfare; Isolation and screening of microbes important for industry – advances in methodology and its application; Advanced genome and epigenome editing tools (e.g., engineered zinc finger proteins, TALEs/TALENs, and the CRISPR/Cas9 system as nucleases for genome editing, transcription factors for epigenome editing, and other emerging tools) for manipulation of useful microbes/strains and their applications; Strain improvement to increase yield of selected molecules, e.g., antibiotics, enzymes, biofuels.	**11**
2	**Environmental applications of microbial technology**: Environmental application of microbes; Ore leaching; Biodegradation - biomass recycle and removal; Bioremediation - toxic waste removal and soil remediation; Global Biogeochemical cycles; Environment sensing (sensor organisms/ biological sensors); International and National guidelines regarding use of genetically modified organisms in environment, food and pharmaceuticals.	**11**
3	**Pharmaceutical applications of microbial technology:** Recombinant protein and pharmaceuticals production in microbes – common bottlenecks and issues (technical/operational, commercial and ethical); Attributes required in industrial microbes (Streptomyces sp., Yeast) to be used as efficient cloning and expression hosts (biologicals production); Generating diversity and introduction of desirable properties in industrially important microbes (Streptomyces/Yeast); Microbial cell factories; Downstream processing approaches used in industrial production process (*Streptomyces sp.,* Yeast).	**11**
4	**Food applications of microbial technology:** Application of microbes and microbial processes in food and healthcare industries - food processing and food preservation, antibiotics and enzymes production, microbes in targeted delivery application – drugs and vaccines (bacterial and viral vectors); Non-recombinant ways of introducing desirable properties in Generally recognized as safe (GRAS) microbes to be used in food (e.g., Yeast) - exploiting the existing natural diversity or the artificially introduced diversity through conventional acceptable techniques (mutagenesis, protoplast fusion, breeding, genome shuffling, directed evolution etc.).	**11**

5	**Advances in microbial technology:** Microbial genomics for discovery of novel enzymes, drugs/ antibiotics; Limits of microbial genomics with respect to use in human welfare; Metagenomics and meta-transcriptomics – their potential, methods to study and applications/use (animal and plant health, environmental clean-up, global nutrient cycles & global sustainability, understanding evolution), Global metagenomics initiative - surveys/projects and outcome, metagenomic library construction and functional screening in suitable hosts – tools and techniques for discovery/identification of novel enzymes, drugs (e.g., protease, antibiotic) etc.	**11**

References:

1. Lee, Y. K. (2013). Microbial Biotechnology: Principles and Applications. Hackensack, NJ: World Scientific.
2. Moo-Young, M. (2011). Comprehensive Biotechnology. Amsterdam: Elsevier.
3. Nelson, K. E. (2015). Encyclopedia of Metagenomics. Genes, Genomes and Metagenomes: Basics, Methods, Databases and Tools. Boston, MA: Springer US.
4. The New Science of Metagenomics Revealing the Secrets of Our Microbial Planet. (2007). Washington, D.C.: National Academies Press.
5. Journals: (a) Nature, (b) Nature Biotechnology, (c) Applied microbiology and biotechnology, (d) Trends in Biotechnology, (e) Trends in Microbiology, (f) Current opinion in Microbiology, (g) Biotechnology Advances, (h) Genome Research
6. Websites: http://jgi.doe.gov/our-science/

Date: 09/10/24 Course Coordinator Subject Committee Chairperson

Dept Name: Biotechnology
Semester-III

DSE1: C. Biofuels and Bioenergy

Course Title: **Biofuels and Bioenergy**	Course code: **24BTH3E1CL**
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. Identify the biofuel sources to use as an alternative energy to fossil fuel.
2. Standardize the process to convert raw material into bioethanol and biobutanol.
3. Standardize the designs and improve the biodiesel production.
4. Standardize the process of conversion to biogas.
5. Exploring different wastewater/waste materials as different biofuel sources and study various parameters to meet the national and international standards and work out economic feasibility of different energy sources.

DSE1: C. Biofuels and Bioenergy

Unit	Description	Hours
1	**Aspects of biofuels:** Types of fuels. Types of Biofuels and their production. Generations of biofuels. Conventional versus renewable energy resources. Need and availability of different alternative fuels. Comparison of Bio-energy Sources. Biofuel feedstocks and their properties. Biochemical Pathways for various of fuel production from biological sources. Biorefinery process. System biology for biofuel production.	**11**
2	**Bioethanol and biobutanol:** Feedstock Production: Sugar crops, Starch crops, Cellulosic crops. Bioethanol and biobutanol Production: Sugar-to-Ethanol Process, Starch-to-Ethanol Process, Cellulose-to-Ethanol Process, Distillation and Dehydration Process. Properties of Bioethanol and biobutanol. Pre-treatment processes and fermentation process. Fermenter design for bio alcohol production and types of fermenters. Technology Applications for Bioethanol: Spark Ignition Engines, Compression Ignition Engines. Fuel Cells. Standardization of Bioethanol Energy Balance of Bioethanol. Bioethanol Emissions: Greenhouse Gas Emissions, Toxic Exhaust Emissions. Sustainability of Bioethanol: Water Issues, Land Use and Biodiversity, Human Health. Economy of Bioethanol	**12**
3	**Biodiesel:** Conventional Diesel. Feedstock Production: Oilseed Crops, Microalgae, Animal Fats, Waste Oils. Fuel production: Oil Extraction, Oil Refining, Blending, preheating Transesterification and emulsification. Biodiesel production by using various microorganisms and algae. Biodiesel Refinery. Properties and Use of Lipid Biofuels: Properties of Pure Plant Oil (PPO), Properties of Biodiesel. Scale up of biodiesel production. Technology Applications for Lipid Biofuels: Compression Ignition Engines for Biodiesel Use, Compression Ignition Engines for	**11**

	PPO Use. Standardization of Lipid Biofuels: Standardization of PPO, Standardization of Biodiesel. Energy Balance of Lipid Biofuels. Emissions of Lipid Biofuels: Greenhouse Gas Emissions, Toxic Exhaust Emissions. Sustainability of Lipid Biofuels: Water Issues, Land Use and Biodiversity, Human Health. Economy of Lipid Biofuels	
4	**Biogas, biohydrogen as fuels:** Conventional gaseous fuels (Natural gas and LPG). Production methods of Biogas. Feedstock Production. Biomethane Production: Digestion Process, Digester Types, Biogas purification. Properties and Use of Biomethane. Technology Applications for Biomethane: Infrastructure Requirements for Biomethane, Vehicle Technologies for Biomethane. Standardization of Biomethane. Biomethane Emissions: Greenhouse Gas Emissions, Toxic Exhaust Emissions. Sustainability of Biomethane. Economy of Biomethane. Biohydrogen: Biohydrogen Processing, Use of Biohydrogen. Microbial fuel cell	**11**
5	**Waste materials as source of Biofuels and life cycle assessment:** Biofuels from different wastes (waste water & biomass) as sources of biofuels. Life cycle assessment of various biofuels by GREET software. Calculate the biofuel cost benefit ratios for various biofuels. Economic impact of biofuels. Status of bio fuel production in India and World.	**10**

References:

1. Yebo Li, Samir Kumar Khanal (2016). Bioenergy: Principles and Applications,1st Edition Wiley-Blackwell Publications.
2. Dominik Rutz and Rainer Janssen (2008). Biofuel Technology Handbook, WIP Renewable Energies, Germany.
3. Sterling MacMillan (2017). Bioenergy: Principles, Technology and Applications, Larsen and Keller Education
4. Nigel G Halford (2015). An Introduction to Bioenergy, Rothamsted Research, UK

Date: 09/10/24 Course Coordinator Subject Committee Chairperson

Dept Name: Biotechnology

Semester-III
DSE2: A. Agriculture Biotechnology

Course Title: **Agriculture Biotechnology**	Course code: **24BTH3E2AL**
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 classical and modern approaches of plant/crop breeding
2. Understand the manipulation of plants for improved traits responsible for stress tolerance and nutrition fortification
3. Understand of preservation and protection of plants/crops

DSE2: A. Agriculture Biotechnology

Unit	Description	Hours
1	**Crop improvement**: Conventional breeding: Pedigree, heterosis and mutation breeding, limitations of conventional breeding, plant Genome – nuclear and cytoplasmic, significance of organelle genomes, genome size and sequence components, molecular markers: definition, properties, types of molecular markers: restriction based and PCR based, RFLP, AFLP, development of SCAR and SSR markers, other markers: CAPS, SNP, Marker Assisted Selection (MAS), screening and validation, trait related markers and characterization of genes involved.	**11**
2	**Plant growth regulators:** Mode of action, effects on in vitro culture and regeneration; in-vitro storage organ formation; callus culture, suspension culture- batch and continuous culture, Protoplast culture, somatic hybridization. micropropagation, Meristem culture, Shoot tip culture and production of virus free plants, somaclonal variations, in-vitro production of haploid plants – androgenesis and gynogenesis, doubled haploid production through distant hybridization, in-vitro and in-vivo pollination and fertilization, embryo culture, embryo rescue, somatic embryogenesis, artificial seeds, germplasm conservation and cryopreservation.	**11**
3	**Mapping genes on specific chromosomes**: QTL mapping, gene pyramiding, transcript mapping techniques, development of ESTs, the concept of gene synteny, the concept of map-based cloning and their use in transgenics, Antisense RNA technology- FlavrSavr Tomato, biopesticides in agriculture (botanicals and microbials), integrated pest management, Production and applications of biofertilizers (bacterial, fungal and algal); Plant secondary metabolites: Control mechanisms and manipulation of alkaloids and industrial enzymes (Shikimate and PHA pathway), importance of secondary metabolites in agriculture.	**11**

4	**Genetic engineering for increasing crop productivity**: Manipulation of photosynthesis, nitrogen fixation and nutrient uptake, Genetic engineering for biotic stress tolerance (Insects, fungi, bacteria, viruses, weeds). genetic engineering for abiotic stress tolerance (drought, flooding, salt and temperature). genetic engineering for quality improvement of protein, lipids, carbohydrates, vitamins (e.g. Golden Rice) & mineral nutrients, production of antibody in plants; Plant genetic resources, GATT & TRIPS, Patenting of biological material, patenting of transgenic organisms and genes, Plant breeders rights (PBRs) and farmers rights, Concerns about GM crops – environmental, biosafety and ethics.	**11**
5	**Plant disease and disease diagnosis:** disease epidemic, Plant pathogen interaction, the plant defense system. Phytoalexins and Immune system in plant, Innate immunity: PAMP*-triggered immunity (PTI) and effector-triggered immunity (ETI). The gene-for-gene model and the hypersensitive response (HR). Systemic acquired resistance (SAR). Disease diagnosis: Traditional methods, Immunological methods: Diffusion, Agglutination, Enzyme linked immuno sorbent assay (ELISA), Immunofluorescence techniques. Molecular techniques: Polymerase chain reaction (PCR), real time-PCR, Randomly amplified polymorphic DNA (RAPD), Restriction fragment length polymorphism, 16s rDNA.	**11**

References:

1. Introduction to plant Biotechnology (2018) 3rd ed., Chawla HS, CRC Press, ASIN: B07LH5S4P3.
2. Applied Biotechnology in Genetic Engineering, Pharmaceuticals and Agriculture (2016) Adam J, Syrawood Publishing House, ISBN: 978-1682862766.
3. Molecular Markers in Plants (2012), Henry RJ, Wiley-Blackwell. ISBN: 978-0-470-95951-0.
4. Genetic Transformation of Plants-Series: Molecular Methods of Plant Analysis (2013) Vol. 23, Jackson JF and Linskens HF, Springer, ASIN: B000PY3TJ0.
5. Plant Biotechnology – The genetic manipulation of plants (2017) 3rd ed., Slater A, Scott N and Fowler M, Oxford University Press. ISBN: 1138407674.
6. Plant Transformation Technologies (2011), 1st ed., Stewart CN and Touraev, A Wiley-Blackwell. ISBN: 9780813821955.

Date: 09/10/24 Course Coordinator Subject Committee Chairperson

Dept Name: Biotechnology
Semester-III
DSE2: B. Food Technology and Nutrigenomics

Course Title: **Food Technology and Nutrigenomics**	Course code: **24BTH3E2BL**
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 concepts of nutraceutical and functional food, and their use for managing chronic diseases

DSE2: B. Food Technology and Nutrigenomics

Unit	Description	Hours
1	**Nutraceutical:** Historical perspective; definition, nature, nutraceutical compounds and their classification based on chemical/biochemical nature with suitable and relevant descriptions; scope and future prospects. Applied aspects of the nutraceutical science, relation of nutraceutical science with other sciences: medicine, human physiology, genetics, food technology, chemistry and nutrition.	**10**
2	**Functional food:** Overview; definition, classification; functional food, functional food science, food technology and its impact on functional food development; markers for development of functional foods; key issues in Indian functional food industry and nutraceutical. Relation of functional foods and nutraceutical (FFN) to foods and drugs.	**10**
3	**Antioxidants and food as remedies:** Concept of free radicals and antioxidants; antioxidants role as nutraceuticals and functional foods. Food as remedies: Nutraceuticals bridging the gap between food and drug; nutraceuticals for specific situations such as cancer, heart disease, diabetes, stress, osteoarthritis, hypertension; nutraceutical remedies for common disorders like arthritis, bronchitis, circulatory problems, hypoglycemia, liver disorders, osteoporosis, psoriasis and ulcers, etc**.**	**12**
4	**Anti-nutritional factors present in foods:** Types of inhibitors present in various foods and their inactivation. Assessment of nutritional status and recommended daily allowances. Effects of processing, storage and interactions of various environmental factors on the potentials of such foods. Marketing and regulatory issues for functional foods and nutraceuticals. Recent development and advances in the areas of nutraceutical and functional foods.	**11**

5	**Introduction to gene-diet interactions:** Nutrigenomics: Scope and Importance to Human Health and Industry. Transporter gene polymorphisms -interaction with effects of micronutrients in humans. Polymorphisms in genes affecting the uptake and transport of omega-6 and omega-3 polyunsaturated fatty acids: interactions with dietary lipids and chronic disease risk. Nutrigenomics approaches to unraveling physiological effects of complex foods. The intestinal microbiota - role in nutrigenomics. Modulating the risk of cardiovascular disease through nutrigenomics; Modulating the risk of diabetes through nutrigenomics; Modulating the risk of inflammatory bowel diseases through nutrigenomics	**12**

References:

1. Prescott and Dunn (1987) Industrial Microbiology 4th Edition, CBS Publishers & Distributors. Prescott and Dunn (2002) Industrial Microbiology, Agrobios (India) Publishers.
2. Crueger W. and Crueger A. (2000) A Text of Industrial Microbiology, 2nd Edition, Panima Publishing Corp.
3. Stanbury P.F, Ehitaker H, Hall S.J (1997). Priciples of Fermentation Technology, Aditya Books (P) Ltd.
4. Adams and Moss Food Microbiology 8. Fraizer and Werthoff Food Microbiology –
5. Joshi and Pandey.Food Fermentation – Microbiology, Biochemistry & Technology, Vol. I & II.
6. Giuseppe Mazza; Functional Foods: Biochemical and Processing Aspects, Volume 1; CRC Press
7. Robert E.C. Wildman; Handbook of Nutraceuticals and Functional Foods, Second Edition; CRC Press
8. Massimo Maffei; Dietary Supplements of Plant Origin; CRC Press
9. Fereidoon Sahidi, Deepthi K. Weerasinghe; Nutraceutical Beverages, Chemistry, Nutrition and Health Effects; American Chemical Society
10. Ronald R. Watson; Vegetables, Fruits, and Herbs in Health Promotion; CRC Press
11. Fruit and Cereal Bioactives: Sources, Chemistry and Applications; ÖzlemTokusoglu; Clifford Hall III; CRC Press
12. Susan Sungsoo Cho, Mark L. Dreher; Marcel; Dekker Handbook of Dietary Fibre
13. Journal Nutrients 2012, 4, 1898-1944; Molecular Nutrition Research—The Modern Way Of Performing Nutritional Science.
14. Journal Nutrients 2013, 5, 32-57; Nutrigenetics and Metabolic Disease: Current Status and Implications for Personalized Nutrition.
15. J Nutrigenetics Nutrigenomics 2011;4:69–89; Nutrigenetics and Nutrigenomics: Viewpoints on the Current Status and Applications in Nutrition Research and Practice.
16. J Am Diet Assoc. 2006;106:569-576; Nutrigenomics: From Molecular Nutrition to Prevention of Disease.
17. The Journal of Nutrition; Nutritional “Omics” Technologies for Elucidating the Role(s) of Bioactive Food Components in Colon Cancer Prevention.
18. Nutrition 25 (2009) 1085–1093; Proteomics at the center of nutrigenomics: Comprehensive molecular understanding of dietary health effects.

Date: 09/10/24 Course Coordinator Subject Committee Chairperson

Dept Name: Biotechnology
Semester-III
DSE2: C. Marine Biotechnology

Course Title: **Marine Biotechnology**	Course code: **24BTH3E2CL**
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. To evaluate marine environment and its physical features.
2. To understand the marine fisheries habitat of India.
3. To estimate the status and the trends of major fishery resources and their conservation.
4. Explain important features of microbial diversity with reference to different niches in Oceans.
5. Learn techniques of microbial culture, evaluation, maintenance preservation and storing for long time use.
6. Describe and discuss marine microbes in terms of physiological competence and biogeochemical role.
7. Analyze microbial eco system function in pelagic and benthic marine habitats.
8. ValiDate: 09/10/24 microbial pathogenesis, host pathogens interaction, diseases diagnosis and their economic important in food industry.

DSE2: C. Marine Biotechnology

Unit	Description	Hours
1	**Marine biology and ecology:** Classification of marine environment, Types of aquatic habitats such as coral reefs, sand dunes, mangroves, sea grasses etc., Diversity and taxonomy of marine organisms (Bacteria, Phytoplankton, zooplankton, seaweeds, sea grasses, mangroves, corals etc.),Species abundance, richness and diversity indices, Biogeography, Recruitment, Growth, Mortality, Culture of microalgae and invertebrates; Habitat preferences, Adaptations in marine organisms and energy transfer, Marine biomass and productivity - primary production, photosynthetic efficiency; secondary production, productivity distribution in ocean environment, Mechanism and factors affecting primary production	**11**

2	**Biodiversity and conservation of aquatic species:** Principles, Importance; Fish genetic resources- survey and distribution; Marine living resources assessment - Principal methods of exploitation of marine living resources, Development of novel methods for optimization of marine aquaculture; Influencing Factors, Planning and management; IUCN criteria-Red List; Wildlife protection Act; International Treaties & conventions; Marine protected Areas, Sanctuaries and Biosphere reserves, Establishment of Marine Parks, in situ and ex situ conservation; Cryopreservation of Gametes or Gene Banking; Institutes and societies involved in conservation; Artificial Hybridization: Heterosis, Control of fish diseases by selection; selective breeding of disease resistant fish	**11**
3	**Marine microbial ecology and diversity:** Introduction: Marine environment, Seawater, Marine sediments, Habitats for marine microorganisms; Diversity of Marine microorganisms: Archaea, Bacteria, Cyanobacteria, Algae, Fungi, Viruses, viroids and prions and actinomycetes in coastal, shallow, deep sea, hydrothermal vents, mangrove and in coral ecosystem; Marine Symbiotic Microorganisms; Ecology: Survival of indigenous organisms and fate of non-indigenous organisms in the marine environment, Predatory-prey relationship (food-web), Degradation of complex molecules, Colonization of surfaces Chemotaxis, Attachment, Symbiotic Association, Quorum sensing, Temperature dependent microbial growth, Lethal and mutagenic factors, Protection system from osmotic damage.	**11**
4	**Microbial and micro-algal technologies in aquaculture:** Bio-floc technology; Aquaponics; Zero water exchange aquaculture system; Aquamimicry; Hydroponics; Raceway system of aquaculture; Micro-algae- indoor and mass-culture methods, Biotechnological approaches for production of important microalgae. Single cell protein from *Spirulina;* vitamins, minerals and Omega-3 fatty acids from micro-algae; enrichment of micro-algae with micronutrients; cell wall polysaccharides of micro-algae; micro algae biomass for removal of heavy metals; Biofuel production from microalgae; metabolic engineering of microalgae for biofuel production.	**11**
5	**Industrial aquaculture technology:** Fish Feed Technology: Types of feed, conventional feed vs functional feeds; Principles of feed formulation and manufacturing, diets suitable for application in different aquaculture systems; feed formulation ingredients; Use of natural and synthetic carotenoids; feed additives; Role of additives; Feed processing: Gelatinization, extrusion Technology, pellet dressing with heat liable nutrients; Post-harvest Biotechnology: Fundamental aspects of freezing, methods of freezing; Delaying of spoilage; Detection of toxic substances and pathogenic microbes; biosensors for toxin detection; Natural biomaterial used for preservation of fish, Antibiotic residual analysis techniques, Microbial and enzymatic standards of different fishery products.	**11**

References:

1. Se-kwon Kim, (2015) Handbook of Marine Biotechnology, Springer,
2. Pelczar M.J. Jr., Chan E.C.S. and Kreig N.R., (2001) Microbiology, (5th Edition), Tata McGraw Hill.
3. Felix, S., (2010) Handbook of Marine and Aquaculture Biotechnology, AGROBIOS INDIA.

4. Gautam, N.C., (2007) Aquaculture Biotechnology, Shree Publishers and Distributors.
5. Lakra, W.S. (2008) Fisheries Biotechnology, Narendra Publishing House.
6. Carl E. Bond, (2006) Biology of Fishes, 2nd Edition, W.B. Saunders Company, Philadelphia.
7. Levitus, (2000) Warming the World Ocean, Science.
8. Naskar K. and Mandal R., (1999) Ecology and Biodiversity of Indian Mangroves. Daya.
9. Jeffrey S. Levinton, CD (2001). Marine Biology: Function, Biodiversity, Ecology.
10. Artikeya, K., (2005) Biodiversity: Extinction and Conservation.

Date: 09/10/24 Course Coordinator Subject Committee Chairperson

Dept Name: Biotechnology
Semester-III
GEC1: A. Introduction to Biomaterials

Course Title: **Introduction to Biomaterials**	Course code: **24BTH3G1AL**
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. Classify biomaterials based on their properties / applications.
2. Select appropriate biomaterial(s) for desired in-vitro or in-vivo clinical application(s).

GEC1: A. Introduction to Biomaterials

Unit	Description	Hours
1	**Introduction:** Definition of biomaterials, requirements & classification of biomaterials, Comparison of properties of some common biomaterials. Effects of physiological fluid on the properties of biomaterials. Classes of materials used in medicine, Metals, Ceramics, Synthetic polymers, Composites, Hydrogels, Bioresorbable and Biodegradable materials, Natural materials, Structure and properties relationships of biological materials.	10
2	**Novel Biomaterials:** Hydrogels, Self-assembling peptides, Implants materials; Metallic implant materials (stainless steels, Co-based alloys, Ti based alloys), Ceramic implant materials (aluminum oxides, hydroxyapatite glass ceramics carbons), Definition of bio ceramics. Common types of bio ceramics: Aluminum oxides, Glass ceramics, Carbons. Bio resorbable and bioactive ceramics. Polymeric implant, Polymers for drug delivery, Polyolefin's, polyamides, acrylic polymers, fluorocarbon polymers, silicon rubbers, acetyls. (Classification according to thermo sets, thermoplastics and elastomers).	11
3	**Properties of Biomaterials:** Biocompatibility, Properties of biomaterials, Physical, Thermal, Electrical and Optical, Surface properties and adhesion of bio-materials and their application to processing, Testing	10

	and clearance of biomaterials.	
4	**Biocompatibility & Toxicological screening of biomaterials:** Definition of biocompatibility, blood compatibility and tissue compatibility. Toxicity tests: acute and chronic toxicity studies (*in situ* implantation, tissue culture, haemolysis, thrombogenic potential test, systemic toxicity, intracutaneous irritation test), sensitization, carcinogenicity, mutagenicity and special tests.	**11**

References:

1. B. D. Ratner, A. S. Hoffman, F. J. Schoen and J. E. Lemons, Biomaterials Science, Second Edition: Wiley Science (2004).
2. L. Hench and J. Jones, Biomaterials, Artificial Organs and Tissue Engineering (Woodhead Publishing in Materials (2002).
3. J. Breme, R. Thul and C. J. Kirkpatrick, Metallic Biomaterial Interfaces Wiley (2008).
4. Temenoff J.S. and Mikos A.G., Biomaterials: The intersection of Biology and Materials Science, Pearson, (2009).
5. Kinam Park, Controlled Drug Delivery: Challenges and Strategies. Washington (DC): American Chemical Society (1997).

Date: 09/10/24 Course Coordinator Subject Committee Chairperson

Dept Name: Biotechnology
Semester-III
GEC1: B. Gene expression and Transgenics

Course Title: **Gene expression and Transgenics**	Course code: **24BTH3G1BL**
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. Understand the mechanisms of gene regulation in various groups of organisms so us to plan the genetic engineering experiments.
2. Understand the regulation of gene during the various stage of development of an organism.

GEC1: B. Gene expression and Transgenics

Unit	Description	Hours
1	**Structure of DNA and its physico-chemical properties:** Prokaryotic and eukaryotic DNA replication- DNA polymerases and proteins involved in DNA synthesis and their specific roles. Structure and properties of RNA polymerases in prokaryotes and eukaryotes. General and specific transcription factors, Mechanism of transcription and post transcriptional modifications of RNAs, RNA editing.	**11**
2	**Prokaryotic and eukaryotic translation:** Features of genetic code, amino-acyl synthases and charging of t-RNA, prokaryotic and eukaryotic translation, regulation of translation. Synthesis of secretary and membrane proteins, import into nucleus, mitochondria, chloroplast and peroxisomes.	**11**

3	**Regulation of gene expression:** Prokaryotic gene expression with reference to inducible and repressible operons. Concept of eukaryotic gene regulation. Genetic basis of pattern formation in Drosophila, homeotic loci. DNA and RNA tumor virus; oncogenes, tumor suppressor genes and their mechanism of action. Antisense RNA and RNA interference. Applications of antisense and ribozyme technologies	**11**
4	**Genetically Modified Organisms-use in Basic & Applied Research:** Introduction Human genome project, Sequence component of eukaryotic genome Cloning by nuclear transfer, transgenic technology, Transgenic mice, Transgenic Drosophila, Transgenic C elegans, Transgenic Zebra Fish, Transgenic Arabidopsis, Transgenic Cattle, Transgenic Chicken, Transgenic Goat, Gene-targeted Mouse models, other applications of Transgenic Animal Technology, Transgenic Plants.	**11**

References:

1. Molecular Cloning: a laboratory manual, Sambrook J., Fritsch EF. and Maniatis T, Cold Spring harbor Laboratory Press, (2000)
2. Introduction to Practical Molecular Biology, DEabre P, John Wiley & Sons Ltd, (1998).
3. Molecular Biology Labfax, T.A. Brown (Ed.), Bios Scientific Publishers Ltd. (1991)
4. Molecular Biology of the Gene, Watson JD., Hopkins NH., Roberts JW., Steitz JA and Weiner AM (The Benjamin/Cummings Publ.Co.), (1996).
5. Molecular Cell Biology, Darnell J, Lodish H and Baltimore D, Scientific American Books, USA, (2000)
6. Molecular Biology of the Cell, Alberts B., Bray D, Lewis J., Ralf M., Roberts K. and Watson J.D., Garland Publishing Inc. (2001)
7. Gene IX, Lewin B, Oxford University Press, (2005). Human Genetics and Genomics ; Korf BR ; 3rd Ed ; Blackwell; 2007
8. Molecular Cloning; 3rd Ed; Sambrook & Russel : Cold Spring Harbour Laboratory press, NY ; 2001
9. ICRF Handbook of Genome Analysis ; Spurr NK , Young BD , Bryant SP;1998

Date: 09/10/24 Course Coordinator Subject Committee Chairperson

Dept Name: Biotechnology
Semester-III
GEC1: C. Biomedical Waste Management

Course Title: **Biomedical Waste Management**	Course code: **24BTH3G1CL**
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. Understand the basics, the Scope and importance of biomedical wastes
2. Learn about types of wastes and composition.
3. Learn about Potential health hazards of biomedical wastes.
4. Learn Direct and Indirect hazards
5. Learn about different approaches and understand the principles and methods of disposal of biomedical wastes.
6. Understand the secured land fill.
7. Learn about the different technologies of treatment and management of biomedical wastes.
8. Learn Conventional treatment technologies.
9. Understand the rules, policies and guidelines of biomedical wastes.
10. Understand the WHO guidelines for biomedical wastes**.**

GEC1: C. Biomedical Waste Management

Unit	Description	Hours

1	**Introduction to biomedical waste:** Introduction, Definition, Scope and importance of biomedical waste. Categories of biomedical wastes (Human Anatomical Waste, Animal Waste, Microbiology & Biotechnology Waste, Waste sharps, Discarded Medicines and Cytotoxic drugs, Solid Waste, Liquid Waste, Incineration Ash and Chemical Waste).	**11**
2	**Health impacts biomedical waste:** Health impacts of biomedical wastes. Direct and Indirect hazards. Potential health hazards of BMW. Infectious agents in the biomedical wastes. Monitoring and controlling of cross infection (Protective devices)	**11**
3	**Handling of biomedical waste:** Biomedical waste – Handling rules, segregation, collection, transportation, disposal-color coding and type of container for disposal of biomedical wastes. Disposal technologies (sharp disposal pit, deep burial pit and secured land fill).	**11**
4	**Treatment and management of biomedical waste:** Treatment and management of biomedical wastes-on site - pre treatments, treatment-in-site and off-site (common treatment facilities). Liquid waste treatment by different technologies. Conventional treatment technologies (wet thermal and incineration)	**11**

References:

1. Sharma – Holistic approach to Hospital Waste Management published by Dept. of
2. Bhide A. D.and B.B.Sundaresan, "Solid Waste Management – Collection, Processing and disposal" Mudrashilpa Offset Printers, Nagpur, 2001.
3. GoelS. L, Hospital Management, 2009.
4. Radhakrishnan R , Biomedical Waste Management ,Neha Publishers &Distributors,2007.
5. BeheraP K, Sustainable Bio-Medical Waste Management (2 Vols.) Dominant Publishers and Distributors 1993.
6. Hosetti,B. B.Prospects and perspective of solid waste management, 2006.
7. Glynn Henry J and Gary. W. Heinke, "Environmental Science and Engineering", Pretice Hall of India, 2004.
8. Bhide A. D and B.B.Sundaresan, "Solid Waste Management – Collection, Processing and disposal" Mudrashilpa Offset Printers, Nagpur, 2001.
9. Glynn Henry J and Gary. W. Heinke, "Environmental Science and Engineering", Pretice Hall of India, 2004.

Date: 09/10/24 Course Coordinator Subject Committee Chairperson

Dept Name: Biotechnology
Semester-III
SEC3: Research Methodology

Course Title: **Research Methodology**	Course code: **24BTH3S3LP**
Total Contact Hours: (L-T-P): **1- 0 - 2**	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. Develop skill in scientific writing, data handling and processing and development of research ideas, planning / designing of research projects.
2. Apply the knowledge and data collection methods in experiments and research work

SEC3: Research Methodology

Unit	Description	Hours
1	**Introduction to Research:** Nature and importance of research- Aims, Objectives and Principles: Fundamental research vs. applied research with examples: Qualitative vs Quantitative research: Theoretical research vs. experimental research with examples: Selection of a research problem and Sources of	**06**

	literature – Journals, Conferences, Books. Types of sources: Literature Survey engines- Scopus, web of Science, Google Scholar, PubMed, NCBI, Scihub, etc. Science citation index: Citations, h-index, i10 index, impact factor.	
2	**Methods of Data Collection:** Data Collection Methods- Framing a hypothesis, designing controlled experiments, choosing the sample-size, sampling bias, importance of independent replicates, conducting an experiment, maintaining a lab-notebook to record observations: Identifying experimental errors. Case-studies on well-designed experiments vs. poorly designed experiments. Correlations vs. Causation. Good laboratory Practices. Introduction to Chemdraw, Chemsketch and other basic software's.	**06**
3	**Data analysis (Practical)** Data Presentation and Writing: Technical presentation, technical writing, Formatting citations; MS Excel for plotting the data (pie chart, plots, bar charts). **Analysis using software tools:** Descriptive Statistics: Mean, standard deviation, variance, plotting data and understanding error-bars. Curve Fitting: Correlation and Regression. Distributions: Normal Distribution, Gaussian distribution, skewed distributions. Inferential Statistics: Hypothesis testing and understanding p-value. Parametric tests: Student's t-test, ANOVA. Tests to analyses categorical data: Chi-square test.	**14**

References:

1. C.R. Kothari, Research Methodology: Methods and Techniques, II Ed. New Age International Publishers, (2009).
2. Shanthibhushan Mishra, Shashi Alok, Handbook of Research Methodology, I Ed, 2017, Educreation Publishers.
3. Basic Statistical Tools in Research and Data Analysis (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5037948/).
4. Introduction to Statistical methods with MATLAB (MATLAB and Simulink Training (mathworks.com)

Date: 09/10/24 Course Coordinator Subject Committee Chairperson

Dept Name: Biotechnology
Semester-III
DSC9P7: Biostatistics and Bioinformatics lab

Course Title: **Biostatistics and Bioinformatics lab**	Course code: **24BTH3C9P**
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. Understand the importance of various databases.
2. Understand various dimension of bioinformatics.
3. Analyze the various databases available for protein and nucleic acids.
4. Learn sequence analysis and to compare between species and individuals

DSC9P7: Biostatistics and Bioinformatics lab

Experiment's
1. Problems on mean, median and mode 2. Problems on variance, coefficient of variance, standard deviation (SD) and standard error (SE)

3. Probability distribution: Normal, binomial and poison
4. Test of hypotheses: Students t-test, X2 distribution (Chi square), correlation coefficient and analysis of variance (ANOVA)
5. Biological databases-file formats.
6. Data retrieval using ENTREZ
7. Searching DNA databases with FASTA and BLAST
8. Searching protein sequence databases with FASTA and BLAST
9. Sequence analysis: Multiple alignment (Clustal W)
10. Motif and domain analysis
11. Phylogenetic analysis
12. Primer designing
13. Gene finding
14. Molecular visualization using Rasmol

References:

1. Bioinformatics: Sequence and Genome Analysis by David W. Mount, Cold Spring Harbor Laboratory Press
2. Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids by Richard Durbin, Sean R. Eddy, Anders Krogh, Graeme Mitchison, Cambridge University Press.
3. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, Second Edition by Andreas D. Baxevanis, B. F. Francis Ouellette, Wiley-Interscience
4. Foundations to bioinformatics – Evolution, similar macromolecular components, constancy of gene number and core proteome in closely related organisms
5. Bioinformatics data – nucleic acid sequence, protein sequence, protein structure, genomic, proteomic and metabolomics information
6. Bioinformatics databases – types, design, file formats, access tools with examples
7. Bioinformatics tools and Resources – free online tools, downloadable free tools, software packages, internet.
8. Statistical Methods, S.P. Gupta
9. Fundamentals of mathematical statistics. S.C. Gupta &Kapoor

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: 09/10/24 Course Coordinator Subject Committee Chairperson

Dept Name: Biotechnology
Semester-III
DSC10P8: Medical Biotechnology and Diagnostics lab

Course Title: **Medical Biotechnology and Diagnostics lab**	Course code: **24BTH3C10P**
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. Apply the concepts of medical biotechnology in disease diagnosis, prevention and treatment.
2. Asses the benefit of hemopoietic stem cells in the treatment of cancer and other diseases.
3. Apply encapsulation technology and stem cells for therapeutics, Regenerative and Nanomedicine

DSC10P8: Medical Biotechnology and Diagnostics lab

Experiment's
1. Bacterial culture: establishing a pure culture; identification of bacteria; staining techniques; antibiotic sensitivity of bacteria.

2. Isolation of plasmid DNA, and its digestion by restriction endonucleases and separation of restriction fragments by agarose gel electrophoresis.
3. Isolation of RNA and separation on agarose gel and Quantitative estimation of RNA.
4. Green fluorescence protein (GFP) and bacterial transformation experiments.
5. Western blot analysis of the proteins using antibodies.
6. Identification and characterization of blood
7. Encapsulation of lymphocytes/ RBCs
8. PCR in disease diagnosis, paternity determination and criminal investigations
9. Denaturation kinetics study of biomolecules using UV-VIS spectrophotometry.
10. Drug identification by spectrophotometric method
11. Determination of aspirin concentration in given sample by spectrophotometry
12. Comparative study for the synthesis, characterization and applications of nanoparticles
13. Video based demonstration for prenatal diagnosis and gene therapy methods

References:

1. Short Protocols in molecular biology (4th edition). John Wiley and Sons, INC. New York, Chichester, Weinheim, Brisbane Singapore, Toronto.
2. Freifeldes, D. (1987). Molecular Biology (2nd edition). Jones and Bartlet Publishers: Boston, Portola Valley.
3. Sambrook, J. and Russell, D. (2001). Molecular Cloning: A laboratory manual. Vol. III, CHSL Press.

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: 09/10/24 Course Coordinator Subject Committee Chairperson

Dept Name: Biotechnology
Semester-IV
DSC11: Plant Biotechnology

Course Title: **Plant Biotechnology**	Course code: **24BTH4C11L**
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,	**11**

	Plant Tissue Culture Media, Cellular totipotency, Factors affecting Tissue Culture success: (Media explant, light, Temperature, Polarity, Subculture, Genotype, Season), Hormones.	
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 pathogens.	**11**
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.
10. Abdin, M. Z., Kiran, U., Kamaluddin, & Ali, A. (2024). Plant Biotechnology: Principles and Applications. Springer.
11. Stewart Jr., C. N. (2024). Plant Biotechnology and Genetics: Principles, Techniques, and Applications. Wiley.
12. Chawla, H. S. (2024). Introduction to Plant Biotechnology. CRC Press.
13. Slater, A., Scott, N. W., & Fowler, M. R. (2024). Plant Biotechnology: The Genetic Manipulation of Plants. Oxford University Press.
14. Heldt, H.-W. (2024). Plant Biochemistry. Academic Press

Date: 09/10/24 Course Coordinator Subject Committee Chairperson

Dept Name: Biotechnology
Semester-IV
DSC12: Animal Biotechnology

Course Title: **Animal Biotechnology**	Course code: **24BTH4C12L**
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.
3. Impart knowledge on artificial breeding, production and applications of transgenic animals.
4. Impart knowledge on isolate and culture of stem cells and their application in biomedical field.
5. 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-	11

	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.	
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 chemicals. Application of functional genomics and discovery of new genes, animal welfare and human health	**11**
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.
9. Verma, A. S., & Singh, A. (2024). Animal Biotechnology: Models in Discovery and Translation. Academic Press.
10. Lanza, R., Langer, R., & Vacanti, J. (2024). Principles of Tissue Engineering (5th ed.). Academic Press.
11. Atala, A., & Allickson, J. G. (2024). Translational Regenerative Medicine. Elsevier.
12. Mason, C., & Dunnill, P. (2024). A Practical Guide to Stem Cell Research. Wiley.
13. Palsson, B. O., & Bhatia, S. N. (2024). Tissue Engineering. Pearson.

Date: 09/10/24 Course Coordinator Subject Committee Chairperson

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

Course Title: **Biosafety, Bioethics and IPR**	Course code: **24BTH4E3AL**
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	**11**

	their ethical aspects. Testing of drugs on human volunteers, organ transplantation and ethical issues; Xenotransplantion and its ethical and social issues. Human Genome project.	
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 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.	**12**
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: 09/10/24 Course Coordinator Subject Committee Chairperson

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

Course Title: **Environmental Bioengineering**	Course code: **24BTH4E3BL**
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	**11**

	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	
4	**Xenobiotic compounds:** aliphatic, aromatics, polyaromatic hydrocarbons, polycyclic aromatic compounds, pesticides, surfactants and microbial treatment of oil pollution. Basic 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.	**12**
5	**Bio-absorption and Bioleaching of heavy metals:** Cadmium, Lead, Mercury, Metal binding targets and organisms, Bio-absorption, Metal microbial interaction, Biomethylation of elements (Methylation of mercury and arsenic), Commercial biosorbents, 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
9. Rittmann, B. E., & McCarty, P. L. (2024). Environmental Biotechnology: Principles and Applications (2nd ed.). McGraw Hill.
10. Jordening, H. J., & Winter, J. (2024). Environmental Biotechnology: Concepts and Applications. Springer.
11. Bhattacharya, B. C., & Banerjee, R. (2024). Environmental Biotechnology. Oxford University Press.
12. Fulekar, M. H. (2024). Environmental Biotechnology. CRC Press.
13. Reineke, W., & Agathos, S. (2024). Biotechnology for the Environment: Soil Remediation. Springer.

Date: 09/10/24 Course Coordinator Subject Committee Chairperson

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

Course Title: **Enzyme Technology**	Course code: **24BTH4E3CL**
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	**12**

	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	
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, sigmoidal 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: 09/10/24 Course Coordinator Subject Committee Chairperson

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

Course Title: **Nanobiotechnology**	Course code: **24BTH4E4AL**
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	**11**

	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	
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 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.	**12**
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 nano mechanics and Computing. Nano diamonds. Biocompatible 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: 09/10/24 Course Coordinator Subject Committee Chairperson

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

Course Title: **Proteomics and Protein Engineering**	Course code: **24BTH4E4BL**
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 docking, Structure based drug design and case studies, Rational protein design, Phage display systems	**11**
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: 09/10/24 Course Coordinator Subject Committee Chairperson

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

Course Title: **Cell signaling**	Course code: **24BTH4E4CL**
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 signaling

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	**11**

	normal cells, apoptosis, therapeutic interventions of uncontrolled cell growth.	
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: 09/10/24 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: **24BTH4G2AL**
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	**11**

	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.	
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 treatment technology. Release of genetically engineered microbes and environmental risk.	**10**
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: 09/10/24 Course Coordinator Subject Committee Chairperson

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

Course Title: **Biology of Immune system**	Course code: **24BTH4G2BL**
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.	**10**

	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.	
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: 09/10/24 Course Coordinator Subject Committee Chairperson

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

Course Title: **Biotechnology for Human Welfare**	Course code: **24BTH4G2CL**
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. 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	**11**

	Health: Antibiotic production, molecular diagnostics, Vaccines and vaccine delivery, recombinant therapeutics- Insulin, gene therapy. human genome project	
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: 09/10/24 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: **24BTH4C11P**
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. Micropropagation 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: 09/10/24 Course Coordinator Subject Committee Chairperson

Dept Name: Biotechnology
Semester-IV
Project: 24BTH4C1R: Research Project

Course Title: **Research Project**	Course code: **24BTH4C1R**
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".

CBCS Question Paper Pattern for PG Semester End Examination

with Effect from the AY 2024-25

Disciplines Specific Core (DSC) and Discipline Specific Elective (DSE)

Paper Code: **Paper Title:**

Time: 3 Hours **Max.**

Marks: 70

Note: Answer any *FIVE* of the following questions with Question No. 1 (Q1) Compulsory, each question carries equal marks.

Q1. 14 Marks

Q2. 14 Marks

Q3. 14 Marks

Q4. 14 Marks

Q5. 14 Marks

Note: Question No.1 to 5, *one question from each unit* i.e. (Unit I, Unit II, ….). The Questions may be a whole or it may consists of sub questions such as a,b, c etc…

Q6. 14 Marks

Note :Question No.6*, shall be from Unit II and III,* the Question may be a whole or it may consists of sub questions such as a,b, c etc…

Q7. 14 Marks

Note: Question No.7*, shall be from Unit IV and V,*the Question may be a whole or it may consists of sub questions such as a,b, c etc…

Q8. 14 Marks

Note: Question No-8 shall be from *Unit II, Unit III , Unit IV and Unit V*. The question shall have the following sub questions and weightage. i.e a – 05 marks, b – 05 marks, c – 04 marks.

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Skill Enhancement Courses (SECs)

Paper Code: **Paper Title:**

Time: 1 Hours **Max.**

Marks: 30

There shall be Theory examinations of Multiple Choice Based Questions [MCQs] with Question Paper set of A, B, C and D Series at the end of each semester for SECs for the duration of One hour (First Fifteen Minutes for the Preparation of OMR and remaining Forty-Five Minutes for Answering thirty Questions). The Answer Paper is of OMR (Optical Mark Reader) Sheet.

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PG IA Question paper pattern

For all DSC and DSE papers

Internals – 2024-25

(Date:)

Semester – I/II/III/IV

Subject:

Answer the following questions **5x2=10**

Q1.

Q2.

Q3.

Q4.

***Total formative Internal Assessment for Semester-I/II/III/IV = 30 marks**

C1 = 10
C2 =10
Seminar and Presentation = 05 Marks for
Assignment/Fieldwork = 05 Marks

Total 10+10+5+5=30marks

PG IA Question paper pattern

For all SEC papers

Internals – 2021-22

(Date:)

Semester – I/II/III

Subject:

Answer any 1 of the following **5x1=5**

Q1.

Q2.

***Total formative Internal Assessment for Semester-I/II/III = 20 marks**

C1 = 05
C2 =05
Seminar and Presentation = 05 Marks for
Assignment/Fieldwork = 05 Marks
Total 05+05+05+05=20marks