Post – Graduate
Programme in Biotechnology

Courses of study, Schemes of Examinations & Syllabi

(Choice Based Credit System)

DEPARTMENT OF BIOTECHNOLOGY & BIOINFORMATICS
BISHOP HEBER COLLEGE (Autonomous)
(Reaccredited with 'A' Grade (CGPA – 3.58/4.0) by the NAAC & Identified as College of Excellence by the UGC)
DST – FIST Sponsored College &
DBT Star College
TIRUCHIRAPPALLI – 620 017
TAMIL NADU, INDIA

2016 – 2017

Post – Graduate Programme in Biotechnology

Structure of the Curriculum

Parts of the Curriculum	**No. of courses**	**Credits**
Core Course (theory)	10	49
Core Course (Practical)	5	15
Elective	4	16
Project	1	6
NMEC	1	2
VLOC	1	2
Total	**22**	**90**

M.Sc., Biotechnology
(For the candidates admitted from the academic year 2016 onwards)

Sem	Course	Course code	Course Title	Pre requisites	Hrs./ week	Credits	Marks		
							CIA	ESA	Total
I	Core I	P15BT101	Cell and Molecular Biology		5	5	25	75	100
	Core II	P15BT102	Biochemistry		5	5	25	75	100
	Core III	P15BT103	Microbiology		5	5	25	75	100
	Core Prac. I	P15BT1P1	Biochemistry and Cell Biology Lab.		5	3	40	60	100
	Core Prac. II	P15BT1P2	Microbiology Lab.		5	3	40	60	100
	Elective I	P15BT1:1/ P15BT 1:2	Bioinstrumentation / Basics of Bioinformatics		5	4	25	75	100
II	Core IV	P15BT204	Animal Biotechnology	P15BT101	5	5	25	75	100
	Core V	P15BT205	Plant Biotechnology	P15BT101	5	5	25	75	100
	Core VI	P16BT206	Industrial Biotechnology	P15BT103	5	4	25	75	100
	Core Prac. III	P15BT2P3	Animal, Plant and Enzyme Technology Lab		5	3	40	60	100
	Elective II	P15BT 2:1/ P15BT 2:2	Research Methodology and Biostatistics / Nanobiotechnology		4	4	25	75	100
	NMEC		***To be selected from the courses offered by other departments***		4	2	25/40	75/60	100
	VLOC	P17VL2:1/ P17VL2:2	RI / MI		2	2	25	75	100
III	Core VII	P15BT307	Gene Technology	P15BT101	5	5	25	75	100
	Core VIII	P15BT308	Immunology		5	5	25	75	100
	Core IX	P15BT309	Medical Biotechnology	P15BT104	5	5	25	75	100
	Core Prac. IV	P16BT3P4	Gene Technology Lab.		5	3	40	60	100
	Core Prac. V	P15BT3P5	Immunology and Medical Biotechnology Lab		5	3	40	60	100
	Elective III	P15BT3:1/ P15BT3:2	Stem Cell Biology / Developmental Biology		5	4	25	75	100
IV	Core X	P15BT410	Environmental Biotechnology		5	5	25	75	100
	Elective IV	P15BT4:1/ P15BT4:2	Biotechnology Management / Biosafety, Bioethics and IPR		5	4	25	75	100
	Project	P16BT4PJ	Project		20	6	--	--	100
TOTAL						**90**			**2200**

CIA- Continuous Internal Assessment **NMEC- Non Major Elective Course**
ESA- End Semester Assessment **VLOC- Value added Life Oriented Course**

Course offered to students from other disciplines as NMEC

NMEC	Human and Environment	P16BT2E1		4	2	25	75	100

CORE COURSE: I - CELL AND MOLECULAR BIOLOGY

Semester : 1 **Course Code : P15BT101**

Credits : 5 **Total Hours : 75**

General Objectives

1. To understand the concept of cell and its activity
2. To know about the internal structure and organization of cells
3. To learn about the cellular processes like cell signaling and metabolism
4. To be aware of genetics, gene expression and its regulation

Unit -I Basics of Cell and Organelles

Discovery-Cell theory-Prokaryotes & Eukaryotes- Cellular Organelles: Structure, Organization and Functions of Plasma membrane, Nucleus & nucleolus, Mitochondria, ER-rough and smooth, Ribosomes, Golgi apparatus, Plastids, Vacuoles, Lysosomes, Peroxisomes and Microbodies. Cell junction.

Unit -II Cell Cycle and Signaling

Overview, Structure and Organization of Microtubules and Microfilaments-Cell movement. Cell Division: Cell Cycle-Regulation of Cell Cycle- Cell signaling- (adrenalin receptors, acetylcholine receptors, insulin receptors) Programmed Cell Death. Transformation, Transduction and Conjugation, Recombination - Generalized and Site specific in bacteria- Holiday model.

Unit -III Overview of genetic material

Structure of DNA and RNA- Composition, Types and Functions, Replication mechanisms - Enzymes involved in replication. Mutation: Origin and Classification - Types- Molecular Mechanism of Mutation- Detection of DNA damage at molecular level, Ames test, cytogenetic analysis in mammalian cells - in vitro and in vivo- Host mediated assay- DNA repair and recombination mechanisms. Transposons and transposable elements- Mechanism of transposition.

Unit - IV Transcription and RNA Processing

Transcription in Prokaryotes and Eukaryotes -Post transcriptional modifications. Genetic code and Translation: Features of genetic code -Deciphering of the codon- Translation in Prokaryotes and Eukaryotes- Post translation modifications- Protein targeting.

Unit -V Regulation of Gene Expression

Cistron, muton and recon -exons and introns. Regulation of gene expression in prokaryotes and eukaryotes -positive and negative control in prokaryotes- Operon models(Lac,Tryp,Ara)- Spatial and Temporal regulation of eukaryotic genes, mi RNA, si RNA,Micro-satellites.

Text Book

1. Geoffrey M Cooper, Robert E Hausman, *The Cell - A Molecular Approach*, 6th Edition, ASM Press, Washington, 2013.

References

1. Harvey Lodish *et al*., *Molecular Cell Biology*, W.H.Freeman & Company, New York, 6th Edition, 2008.
2. Gerald Karp, *Cell and Molecular Biology*, Third edition, John Wiley & Sons, New York, 2001.
3. Alberts *et al*., *Essential Cell Biology* : An Introduction to the Molecular Biology of the Cell, 2nd Edition, Garland Science Taylor & Francis Group, New York, 2003.
4. Benjamin A. Pierce, *Genetics - A Conceptual Approach,* W.H.Freeman & Company, New York, 2nd Edition, 2006.

CORE COURSE: II – BIOCHEMISTRY

Semester : 1 **Course Code : P15BT102**
Credits : 5 **Total Hours : 75**

General Objectives

1. To acquire an in-depth knowledge about the various biomolecules both structurally and functionally.
2. To know about the other dimensions of the metabolic formation and regulation of various biological pathways.
3. To understand the role of biomolecules and their regulations in various diseases and disorders.

Unit- I

Chemistry of Biomolecules

Structure of atoms, molecules and chemical bonds; Covalent and Noncovalent interactions - Van der Waals, Electrostatic, Hydrogen bonding and hydrophobic interactions. Chemical foundations of Biology- pH, pK, acids, bases and buffers, Henderson - Hasselbach equation, biological buffer solutions. Energy metabolism (concept of free energy); Principles of thermodynamics; Kinetics, dissociation and association constants.

Unit –II

Carbohydrates and Lipids

Monosaccharides, Disaccharides, Polysaccharides – Types, properties & their role. Homoglycans: structure and properties of starch, glycogen and cellulose. Heteroglycans: structure and properties of agar, alginic acid (sea weed polysaccharide), glycosaminoglycans and pectins.

Lipids: Triglycerides, phosphoglycerols, derived lipids-steroids, prostaglandins and leukotrienes. Membrane lipids and their alignment in membrane.

Unit – III

Amino acids, Proteins & Lipids

Amino acids: General structure and classification. Glutathione: synthesis and function. Phenylalanine and tyrosine metabolism, Tetrapyrole from glycine, Cysteine and methionine metabolism, Coenzyme A from valine, aspartate and cysteine. Polyamines from methionine and arginine.

Proteins: Peptide bond, Primary structure of proteins, structural comparison at secondary, tertiary levels (Ramchandran map), quaternary and domain structure. Protein sequencing strategies – chemical and enzymatic.

Unit – IV

Concept of Enzymes & Kinetics

Classification of enzymes. Mechanisms of enzyme action; Estimation of Michaelis - Menten parameters, Lineweaver – Burk Plot, types of inhibition & models for substrate and product. Allosteric regulation of enzymes, pH and temperature effect on enzymes, Enzyme immobilization.

Unit – V

Metabolism

General scheme of metabolism, glycolysis – aerobic and anaerobic, regulation. Krebs cycle and its regulation; HMP shunt, glyoxylate and glucoranate pathways Cori's cycle. Interconversion of sugars, gluconeogenesis, synthesis of disaccharides and polysaccharides. Glycogenesis, gluconeogenesis and glycogenolysis and their regulation. TCA cycle and its central role in metabolism. Biosynthesis of purines and pyrimidines, Oxidation of fatty acids; Biosynthesis of fatty acids.

Text Books

1. A.C. Deb, *Fundamentals of Biochemistry*, New Central Book Agency, Calcutta, 7th Edition, 2001.
2. J.David Rawn, *Biochemistry*, Neil Patterson Publications, 2005.

References

1. Nelson, L. D. and M. M Cox, *Lehninger's Principle of Biochemistry*, Macmillan, Worth Publication Inc., 6th Edition, 2013.
2. Berg, J.M., Stryer L., *Biochemistry*, W.H. Freeman & Co. NY, 7th Edition, 2007.
3. Thomas M. Devlin, *Biochemistry with Clinical Correlation*, Wiley- Liss Publication, 5th Edition, 2002.
4. Voet & Voet , *Biochemistry*, John Wiley and Sons, 2nd Edition,1995.
5. Jeoffrery Zubay, *Biochemistry*, Wm C. Brown Publications, 3rd Edition, Volumes 1, 2, 3, 1993.
6. Jeoffrery Zubay, *Principles of Biochemistry*, Wm C. Brown Publications, 4th Edition, 1995.
7. Mathews C.K. and K.E.van Holde, *Biochemistry,* Benjamin/ Cumming Publications, 1990.
8. Satyanarayana, *Biochemistry*, U. Books and Allied Pvt. Ltd., Calcutta, 1999.

CORE COURSE: III - MICROBIOLOGY

Semester : 1 **Course Code : P15BT103**
Credits : 5 **Total Hours : 75**

General Objectives

1. To understand the role of microbes in human health
2. To know about the various applied aspects of microbiology

Unit -I

History of Microbiology

Origin of Microbiology (contribution of various scientists), Classification and Characteristic features of Micro organisms. Classification of bacteria (three kingdoms, five kingdoms, domain concept & Bergey's classification). Bacterial taxonomy - New approach (16S rRNA, Numerical, DNA-DNA hybridization)

Unit -II

Physiology

Structure and synthesis of bacterial cell wall, Bacterial respiration, bacterial photosynthesis and reproduction(sexual & Asexual) Bacterial growth & measurement of growth, Media – types and preparation- methods of preservation and storage of microbes. Culture of viruses.

Unit - III

Antimicrobials

Antimicrobial agents - physical and chemical. Antibiotics (each with one example) affecting cell membrane, nucleic acid synthesis, protein synthesis and metabolism & their side effects - Antifungal and antiviral drugs. Drug resistance. Bioactive natural products.

Unit -IV

Applied Microbiology

Bioinsecticides, Mycoinsecticides - advantages and mode of action - *Bacillus thuringiensis*, Baculoviruses. Biodegradation of xenobiotics, Bioleaching, Biodetoriation, Bioremediation, Phytoremediation. Microbes in Petroleum extraction.

Unit -V

Diseases

Microbial Disease- Water borne disease (Cholera), food borne disease (Typhoid), Air borne (pneumonia), Sexually transmitted disease (Syphilis), Vector borne disease (Malaria), Viral disease (Rabies, HIV).

Text Book

1. Prescott, Harley, Klein, *Microbiology* , 10th Edition, McGraw – Hill, 2016.

Reference Books

1. Glazer and Nikaido, *Microbial Biotechnology*, 2nd Edition, Cambridge University Press, 2007.
2 Ronald M. Atlas, Richard Bartha.R, *Microbial Ecology - Fundamentals and Applications*, Pearson Education Limited, 2004.
3 Adams, Martin. R. Moss, Maurice. O, *Food Microbiology*, 3rd Edition, Royal Society of Chemistry Cambridge, 2004.
4. Jacquelyn G Black. *Microbiology Principles & Explorations*, 7th Edition, 2008.
5. Brenner O.J., Krieg, N. R., Staley, J.T., *Bergey's, Manual of Systematic Bacteriology,* 2nd Edition, Springer, New York, 2005.
6. Gerard J. Tortora, Berdell R. Funke, Christian L.Case., *Microbiology: An Introduction,* 9th Edition, Benjamin Cummings Publications, 2006.

CORE PRACTICAL : I - BIOCHEMISTRY AND CELL BIOLOGY

Semester : 1 **Course Code : P15BT1P1**
Credits : 3 **Total Hours : 75**

General Objectives

1. To understand the concepts of molarity and normality
2. To acquire practical skills in operation of instruments
3. To know about isolation of DNA

Biochemistry

1. Preparation of primary and secondary solutions (Molarity and Normality).
2. (Colorimetry): To demonstrate Beer lambert's law and construction of standard graph
3. Spectrophotometry: Quantitative estimation of biomolecules by means of spectrophotometer.
   - Estimation of Protein by Bradford Method
   - Estimation of Carbohydrates(Glucose & Starch) by Anthrone Method
   - Estimation of Cholesterol by Zaks Method
4. Absorption spectra of Proteins and Nucleic Acids
5. Determination of Pka values of Buffers
6. Paper Chromatography of Amino Acids.
7. Thin Layer Chromatography of Plant Pigments.

Cell Biology

1. Mitosis of Onion root tip
2. Observation of Giant Chromosomes from Chironomus larva
3. Isolation of DNA from Buccal smear
4. Isolation of Genomic DNA from plants
5. Isolation of Genomic DNA from animal tissues

References

1. Jayaraman. J, Techniques in biology, Higginbothams Pvt., Ltd., 1972.
2. Jayaraman. J, Laboratory manual in Biochemistry, Wiley Eastern Ltd.,1992,
3. Sam Brook *et al*., Molecular Cloning : A Laboratory Manual Volumes I – III, Cold spring Harbor Laboratory, 1989.
4. Frederick M. Ausbel, Roger Breut, Short protocols in Molecular Biology, Volumes I & II, 5th Edition, John Wiley & Sons Inc., 2002.

CORE PRACTICAL : II - MICROBIOLOGY LAB

Semester : 1 **Course Code : P15BT1P2**
Credits : 3 **Total Hours : 75**

General Objectives

1. To be familiar with staining techniques
2. To have hands on experience on pure culture techniques

1. Simple staining
2. Gram staining (Differential staining)
3. Fungal staining
4. Pure culture techniques-Streak, Spread, Pour plate
5. Isolation & Enumeration of organisms from soil and water
6. Cultivation of bacteria, fungi and Actinomycetes
7. Turbidometric measurement of bacterial growth
8. Demonstration of motility by hanging drop technique

References

1. Collins J, Microbial methods, CRC Press, 7th Edition,1995.
2. Robert Cruickshank, Medical Microbiology - A Guide to the laboratory Diagnosis & Control of Infection, Churchill Livingstone Publishers, Volume 1, 12th Edition, 1973.
3. Cheever F.S., Laboratory Manual of Microbiology, Pubmed Central, 2006.

ELECTIVE : I – BIOINSTRUMENTATION

Semester : 1 **Course Code : P15BT1:1**
Credits : 4 **Total Hours : 75**

General Objectives

1. To learn the basic principles of various bio-analytical instruments
2. To obtain knowledge on the biological applications of the bio-analytical instruments

Unit - I

Electrochemistry and Centrifugation

Principles of Electrochemical Techniques, Redox Reactions, the pH Electrode, Glass Electrode and Reference Electrode. Centrifugation: Small Bench Top Centrifuges, Large Capacity Refrigerated Centrifuges, High Speed Refrigerated Centrifuges, Preparative and Analytical Ultra Centrifuge.

Unit - II

Chromatography

Principles of Chromatography, Ion Exchange and Affinity Chromatography. High Performance Liquid Chromatography (HPLC), Gas liquid Chromatography (GLC), Thin layer Chromatography (TLC), Paper Chromatography.

Unit - III

Electrophoresis

Principles of Electrophoresis, Electrophoresis of Proteins: SDS-PAGE, 2D-PAGE, Detection, Estimation and Recovery of Proteins, Electrophoresis of Nucleic Acid: Agarose Gel Electrophoresis of DNA, Pulsed Field Gel Electrophoresis.

Unit - IV

Spectroscopy and Microscopy

Properties of Electromangnetic Ionic Radiation. UV and Visible Spectroscopy, FTIR, Infrared and Raman Spectroscopy, Nuclear Magnetic Resonance Spectroscopy, ICP, Spectrofluorimetry ,Mass Spectroscopy (GC-MS),and XRD. Types of Microscopes-TEM and SEM.

Unit - V

Radioactivity

The nature of radioactivity, detection and measurement of radioactivity: detection based on gas ionization- Geiger Muller Counter- principles and applications. Detection based on excitation- Liquid Scintillation Counter- principles and applications. Supply, storage and purity of radio labelled

compounds, specific activity, inherent advantages and restrictions of radiotracer experiments, safety aspects, applications of radio isotopes in biological sciences. Autoradiography labeling.

Text Book

1. Keith Wilson and John Walker, Principles and Techniques of Biochemistry and Molecular Biology, 7th Edition, Cambridge University Press, London, UK, 2010.

Reference

1. Douglas A.Skoog, F.James Holler and Stanley R.Crouch, Instrumental Analysis, Cengage Learning India Pvt., Ltd., New Delhi, 2009.
2. Puri B.R., L.R.Sharma and Madan S.Pathania, Principles of Physical Chemistry, Vishal Publishing Co., Jalandhar, 2005.
3. Harborne J.B., Phytochemical Methods – A Guide to Modern Techniques of Plant Analysis, 3rd Edition, Chapman and Hall (L), London, 1998.
4. Singh P.R., Gupta D.S. and K.S. Bajpal, Experimental Organic Chemistry - Basic Techniques and Preparations., Volume 1, Tata McGraw-Hill Publishing Company Ltd., 1980.

ELECTIVE : I - BASICS OF BIOINFORMATICS

Semester : 1 **Course Code : P15BT1:2**
Credits : 4 **Total Hours : 75**

General Objective

1. To acquire basic understanding of Bioinformatics and their applications to molecular biology, clinical medicine and other disciplines.

Unit - I

Introduction to Bioinformatics

Overview- Definition and History. Milestones in Bioinformatics. Methods in Bioinformatics. Role of Bioinformatics in various fields. Useful Bioinformatics web sites. Dogmas: Central and Peripheral. Introduction to single letter code of aminoacids, symbols used in nucleotides.

Unit – II

Biological Data and Databases

Introduction to Biological Databases- Nucleotide sequence database, Protein sequence & Structure Databases, Organism specific databases, Metabolic pathway databases, Bibliographic databases, Biodiversity databases and Specialized databases.

Unit - III

Sequence formats and Information retrieval

Sequence formats in Biological databases- FASTA, Phylip, Clustal, Genbank, EMBL, SWISS PROT. Data retrieval- Entrez, SRS, Protein identification resources (PIR), Expasy, Ensembl.

Unit-IV

Database Searches

Similarity, homology, assessing significance of sequence similarity-Z score, P value, E value, Similarity search programs- fast searching methods-BLAST, FASTA, Dynamic programming searching methods, profile based methods-PSI-BLAST, Sensitivity and Specificity.

Unit – V

Applied Bioinformatics

Commercial bioinformatics, Survey of bioinformatics companies in India and abroad –Economics prospects, pharamainformatics, combinatorial chemistry, HT screening – in silico screening - from lead to commercialization.

Text Book

1. Arthur M. Lesk, Introduction to Bioinformatics, Oxford University Press, New Delhi, 2003.

References

1. Attwood, T.K and D.J. Parry-Smith, Introduction to Bioinformatics, Pearson Education Ltd., New Delhi, 2004.
2. Westhead D.R., J.H Parish and R.M. Twyman, Instant notes in Bioinformatics, Viva Books Pvt. Ltd., 2003.
3. Manju Bansal, Basic Bioinformatics, Atlantic Publishers & Distributors, 2009.

CORE COURSE: IV - ANIMAL BIOTECHNOLOGY

Semester : 2 **Course Code : P15BT204**
Credits : 5 **Total Hours : 75**

General Objectives

1. To learn the basics of animal cell culture techniques
2. To know the various tools used for manipulating animal cells

Unit - I

Animal Cell Culture

Development and maintenance of cell lines, continuous cell lines, culture Media for cultured cells & tissues - natural & defined media, Preparation of various tissue culture media, sterilization, Cell hybridization, hybridoma & monoclonal antibodies production. Cell synchronization.

Unit - II

Biology and Methods of Construction of Animal Viral Vectors

SV 40, adeno virus, retro virus, vaccinia virus, herpes virus, adena associated virus and Baculo virus. Recombinant vaccines (r-subunit vaccine, r-live vaccines, Anti-idiotipic, edible vaccines), Interferon and growth factor and other therapeutic proteins.

Unit - III

Conventional Methods of Animal Improvement

Selective and Cross Breeding. Artificial insemination, Super ovulation, Oestrus Synchronization. In vitro maturation of animal oocytes - Methods of transferring genes into animal oocytes, eggs, embryos and specific tissues - IVF - gamete selection - In vitro culture of Oocyte / embryo and storage. Embryo collection, sex selection and transfer. Somatic cell cloning.

Unit - IV

Transgenics

Transgenic animal production and application; transgenic animals as models for human disease; transgenic animals in livestock improvement; transgenic in industry; chimera production; xenografting; ethical issues in animal biotechnology. DNA based diagnostics.

Unit - V

Gene Therapy

Types, vectors and sites of gene therapy, Ex Vivo and in Vivo methods, clinical trials, treatment of genetic disorders, ethical issues, ethical committee functions. Antisense and ribozyme therapy, Human genome project and Next Generation Sequencing (NGS).

Text Book

1. Primrose, S.B, Twyman, R.W., Principles of Gene Manipulation and Genomics, Seventh edition, Wiley Blackwell, 2006.

References

1. Babiuk, L.A., John. P.Phillips and Murray Moo-young, Animal Biotechnology, Pergamm Press, Oxford, 1989.
2. Freshney. R.I, Culture of Animal cells: Manual of Basic technique, 4th Edition, John Wiley Publications, 2000.
3. Primrose S.B, Molecular Biotechnology, Panima Publications, New Delhi, 2001.
4. Glick B.R and Pasternak Jack J, Molecular Biotechnology - Principles and Applications of Recombinant DNA, 3rd Edition, American Society for Microbiology, 2003.
5. James D. Watson, Amy A. Caudy, Richard M. Myers, Jan A. Witkowski, Recombinant DNA: Genes and Genomics: A short course, 3rd Edition, W.H.Freeman & Co Ltd, 2006.
6. M.M. Ranga, Animal Biotechnology, 2nd Edition. Agrobios, India, 2004.

CORE COURSE : V - PLANT BIOTECHNOLOGY

Semester : 2 **Course Code : P15BT205**
Credits : 5 **Total Hours : 75**

General Objectives

1. To learn about genome organization in plants
2. To understand the basic techniques in plant tissue culture and their applications
3. To acquire knowledge in the area of genetic transformation in plants

Unit – I

Genome Organization in Plants

Genome Organization in Nucleus, Chloroplast and Mitochondria, Molecular Marker-Aided Breeding: RFLP maps, Linkage Analysis, RAPD markers, STS, Microsatellites. Plant Hormones – Biosynthesis, storage, breakdown and transport; physiological effects and mechanisms of action.

Unit – II

Plant Cell and Tissue Culture

Brief historical account, Laboratory organization, Tissue culture media composition and preparation, Callus and Cell suspension culture, Somaclonal variation, Micropropagation, Organogenesis, Somatic embryogenesis, Embryo culture, Synthetic seeds, Protoplast isolation, Somatic hybridization and Cybrids, Anther, Pollen and Ovary culture for production of haploid plants.

Unit – III

Plant Genetic Transformation Methods

Cryopreservation and DNA banking for Germplasm conservation. Production of secondary metabolites, Genetic engineering of metabolic pathways, Production of secondary metabolites in bioreactors and downstream processing.

Unit – IV

Application of Plant Genetic Transformation

Agrobacterium and Crown gall tumours, Mechanism of T- DNA transfer, Ti and Ri plasmid vectors, Agro infection. Direct transfer of plants by physical methods, Selectable marker and reporter genes, Chloroplast transformation. Mechanism of soil bacteria and cyanobacteria for enhanced nitrogen fixation, Azola as biofertilizers, advantage of biofertilizers over chemical fertilizers, activity to control insect pests, Plant host-insect interactions- *nif* and *nod* genes.

Unit – V

Metabolic Engineering and Biopharmaceuticals

Transgenic plants: Genetic engineering of plants for herbicide resistance, Pest resistance, Virus resistance, Disease resistance, Stress tolerance, Cytoplasmic male sterility, Delayed fruit ripe ning. Genetic engineering in floral industries Genetic engineering of seed storage proteins. Vaccine production in plants-plantibodies, Edible vaccine, Transgenic plants: Bt cotton, Bt brinjal, vitamin enrichment, Golden rice.

Text Book

1. Mantell, S.H and Smith. H, Plant Biotechnology, Cambridge University Press, UK, 1983.

References

1. Mantel, Mathews and Mickee, An Introduction to genetic engineering in plants, Blackwell Scientific Publishers, London,1985.
2. R.L.M. Pierik, *In Vitro* culture of higher plants, Martinus Nijhoff Publisher, Dordrecht, 1987.
3. R.A. Dixon and R.A.Gonzales, Plant cell culture - A practical approach, 2nd Edition, Oxford University Press, Oxford,1994.
4. Donald Grierson and S.V. Convey, Plant Molecular Biology, Blackie and Son Limited, New York, 1984.
5. R.J. Henry, Practical Application of Plant Molecular Biology, Nelson Thornes Publishers, 1997.
6. Kirsi-Marja Oksman- Caldentey and Wolfgang H. Barz, Plant Biotechnology and Transgenic Plants, Marcel Dekker, New York, 2002.

CORE COURSE : VI - INDUSTRIAL BIOTECHNOLOGY

Semester : 2 **Course Code : P16BT206**
Credits : 4 **Total Hours : 75**

General Objectives

1. To know about enzymes involved in industrial processes
2. To acquire knowledge on the production of various industrially important bio-products
3. To understand the kinetics of enzyme based reactions

Unit - I

Industrial Fermentation

Screening of new metabolites, Primary and Secondary metabolites strain development for metabolite production, substrates used for industrial fermentation; Carbon and Nitrogen sources, Methods of fermentation, batch and continuous fermentation, Different fermentation systems, Different stages of fermentation process

Unit - II

Fermentor Design

Fermentor - Design & Types: Gaden's Fermentation classification, design and operation of fermentors, Basic concepts for selection of a bioreactor, impellers, baffles and sparger, sterilization. Types of reactor- submerged reactor - mechanically stirred draught- tube reactor- continuous flow stir type reactor - airlift reactor- jet loop reactor, surface reactor, packed bed
reactor, Fluidized bed reactor.

Unit - III

Product Recovery

Scale up fermentation process, downstream processing. Different unit operations in product recovery, product purification, yield coefficient.

Production of Secondary Metabolites

Commercial production and application of amino acids (L-glutamic acid, L-lysine and L-tryptophan). Enzyme production and their applications in large scale level: amylase, glucose isomerase, protease, lipase, penicillin acylase and lactase. Production of vitamins and antibiotics (Penicillin, Cephalosporins and Tetracyclin).

Unit - IV

Production of Bioproducts

Large scale production and applications of Single cell proteins, Mushroom cultivation, Biosynthesis of growth hormones. Extracellular polysaccharides, Fermented foods, Alcoholic beverages (beer and wine).Microbial transformations, Bioconversion of steroid and Non-steroid compounds.

Unit - V

Modern Biotechnology Products

Newer approaches to sewage treatment, treatment process, Biogas: methane production, Role of microorganisms in leaching and mining, Biosynthesis of growth hormones. Extracellular polysaccharides, Fermented foods, Alcoholic beverages (beer and wine).

Text Books

1. Stanbury P.F., A. Whitaker and SJ. Hall, Principles of Fermentation Technology, Butterworth-Heinemann Publishers, 3rd Edition, 2016.
2. Cruger, W. and Crueger, A., Biotechnology : A Textbook of Industrial Microbiology, 2nd Edition, Panima Publishing Corporation, New Delhi, 2004.

References

1. Murrey Moo and Young, D., Comprehensive Biotechnology, Pergamon, New Delhi, 2001.
2. Behrens, D. and Kramer, Bioprocess Engineering : Down Stream Processing and Recovery of Byproducts, Safety in Biotechnology and Regulations. P., 1990.
3. James M. Lee, Biochemical Engineering, PHI, USA, 2nd Edition, 1992.
4. James. E. Bailey & David F. Ollis, Biochemical Engineering Fundamentals, McGraw Hill, 2nd Edition 1986.
5. Presscott, D., Industrial Microbiology, CBS Publishers, New Delhi, 1999.
6. Sathyanarayana, U., Biotechnology, Books and Allied (P) Ltd, Kolkatta, 1997.

CORE PRACTICAL : III - ANIMAL, PLANT & ENZYME TECHNOLOGY LAB

Semester : 2 **Course Code : P15BT2P3**
Credits : 3 **Total Hours : 75**

General Objectives

1. To acquire hands on experience in basic techniques of animal cell culture
2. To understand the methods of plant tissue culture
3. To become familiar with the kinetics of enzyme action

1. Media Preparation for Animal Cell Culture
2. Giemsa Staining
3. Cell viability
4. Primary cell Culture
5. Serum Preparation

PLANT BIOTECHNOLOGY LABORATORY

1. Micropropagation of medicinal plants
2. Callus induction
3. Somatic Embryogenesis
4. Synthetic seeds

INDUSTRIAL BIOTECHNOLOGY

1. Isolation and screening of antibiotic producers by crowded plate technique
2. Isolation and screening of microorganism producing proteases
3. Isolation and screening of microorganism producing amylases
4. Isolation of Nitrogen fixers from soil

References

1. F .S. Cheever, Laboratory Manual of Microbiology, Pubmed Central, 2006.
2. Kanika Sharma, Manual of Microbiology Tools and Techniques, Anshan Ltd., 2007.
3. R. Ian Freshney, Culture of Animal Cells: A Manual of Basic Technique, 5th edition, John Wiley and Sons Inc., Hoboken, New Jersey, 2005.
4. Lingaraj Sahoo, Plant Biotechnology Laboratory Manual, IIT Gwahathi, 2012.
5. Cooney, Wang and Daneil, Computer aided material balancing for production of fermentation parameters, Biotech. Bio Engg. Volume 19, 1977.
6. Scragg, Bioreactors in Biotechnology - A practical approach, Ellis Harwood Ltd, 1991.
7. Janarthanan, S and Vincent, S., Practical Biotechnology, 1st Edition, Universities Press, Hyderabad, 2007.

ELECTIVE : II - RESEARCH METHODOLOGY AND BIOSTATISTICS

Semester : 2 **Course Code : P15BT2:1**

Credits : 4 **Total Hours : 60**

Objective

1. To acquire knowledge in research methodology and biomedical computation

Unit – I

Research Design

Meaning of research, design, research method versus methodology, objectives of research, Types of research, Types of research , significance of research, Criteria of good researches.

Unit – II

Research Problem

Defining of Research problem, Research Design-Meaning – need – Features – Concepts relating to research design – Different Research design –basic Principles of Experimental Design.

Unit – III

Interpretation and Report Writing

Interpretation – Meaning, Technique, Precaution; report writing – Significance, Steps in Report Writing –Significance, Steps in Report writing Layout of research report and thesis writing Preparation of manuscript for publication, Citation and Bibliography, Impact factor.

Unit – IV

Scope of Biostatistics

Scope on Biostatistics in biological research – Variables –Data; Sources and Collection Classification, Presentation; Measure of /central Tendency- Mean(Arithmetic),median-mode, Measures Dispersion-Standard deviation and Standard error-Skewness and kurtosis, coefficient of Variance.

Unit - V

Correlation

Correlation types, Correlation Coefficient , Regression – Simple Linear Regression, Basis Idea of significance test - Hypothesis testing –Type I error – Level of Significance –tests based on Student test, Chi Square Test, ANNOVA,'F' TEST (one way analysis). Introduction to SPSS.

Text Book

1. Panner Selvam R, Research Methodology, Prentice Hall of India Private Limited, New Delhi, 2006.

References

1. Pillai R. S. N and Bhavathy V, Statistics, S.Chand Company Ltd., 2005.
2. Joseph G, MLA, Hand Books for Writers of Research Papers, 6th Edition, Affiliated East West Press Pvt. Ltd, New Delhi, 2004.
3. Prasad S, Elements of statistics, 1st Edition, Jaico Publishing Home, Mumbai, 2004.

ELECTIVE : II - NANOBIOTECHNOLOGY

Semester: 2 **Course Code : P15BT2:2**
Credits: 4 **Total Hours : 60**

General Objectives

1. To learn the basics of nanobiotechnology.
2. To gain knowledge on novel nanomaterials with biological properties
3. To understand the assemblage of ionic complementary peptides and their applications in nanobiotechnology.
4. To know about nucleic acid engineered nanomaterials and their applications.

Unit - I

Biology Inspired Concepts

The nanoscale dimension and paradigm, Biomolecules at nanoscale, Introduction to nanoscience - From biotechnology to nanobiotechnology –Transformation of biological concepts into nanoscience- Reflections of Nanotechnology on nanobiotechnology .

Unit – II

Nanomaterials - Synthesis and Types

Nanoparticle synthesis- The principle of self assembly – Top down and bottom up approaches- Synthetic method –physical and chemical method-Biological method –using plants and microorganisms. Types of nanomaterials -Quantum, wells, wires and dots-nano rods, nanowires, nano fibers, nano shells-Nano tubes-Carbon nano tubes (CNTs).

Unit - III

Applications in Medical Diagnosis

Improved medical diagnosis - Sensor Technology,Biosensors,Nano Immunosensors- Cancer cell screening - i*n vivo* imaging capabilities by enabling the detection of tumors, - ability to control or manipulate on the atomic scale- Nanobot medical devices - logic and intelligence embedded into medical devices- standalone sensing and computing devices.

Unit - IV

Nano Pharmaceuticals and Drug Delivery

Developing of Nanomedicines- Nanosytems in use, Protocols for nano drug Administration,-Nanoscale Delivery of Therapeutics for Drug Delivery-Nanosuspension Formulations Viruses, Trojan Nanoparticles Self Assembling Nanoparticles for Intracellular Drug Delivery Nanoparticle Combinations for Drug Delivery Liposomes -Liposome Nanoparticle Hybrids Nanospheres-Nanomolecular Valves for Controlled Drug Release Nanomotors for Drug Delivery.

Unit - V

Future Challenges and Applications

Prosthetic and medical implants -New generations of prosthetic and medical implants - artificial organs and implants- artificial scaffolds or biosynthetic coatings - biocompatibility and reduced rejection ratio - retinal, cochlear and neural implants - repair of damaged nerve cells and replacements of damaged skin, tissue, or bone, Future upcoming prospective of nanoscience in the field of Biotechnology.

Text Books

1. Jain K.K., Nanobiotechnology in Molecular Diagnostics: Current Techniques and Applications, Horizon Biosciences, 2006.
2. Niemeyer C.M, Mirkin C. A, Nanobiotechnology concepts, Applications and Perspectives, Willey - VCH Weinheim, 2006.

References

1. Mark Ratner and Daniel Ratner, Nanotechnology : A Gentle Introduction to the Next Big Idea, 2002.
2. E.L. Wolf, Nanophysics and Nanotechnology, Wiley Publications, 2006.
3. Tuan Vo Dinh, Nanotechnology in Biology and Medicine: Method, Devices and Applications by, CRC Press, 2007.
4. CNR Rao, The Chemistry of Nano material: Synthesis, Properties & Applications, Volumes I &II by Springer, 2006.
5. http://www.zyvex.com/nanotech/feynman.html

CORE COURSE : VII - GENE TECHNOLOGY

Semester : 3 **Course Code : P15BT307**
Credits : 5 **Total Hours : 75**

General Objectives

1. To know about gene and their role on living systems
2. To know about the vectors
3. To know about the various genetic engineering techniques
4. To apply genetic engineering to produce GM products

Unit – I

DNA Modifying Enzymes and Molecular Scissors

Generation of DNA in prokaryotic and eukaryotic system, Construction of cDNA library, Cutting and joining of DNA molecules - exonucleases, endonucleases, ligases, DNA modifying Enzymes - methylase, alkaline phosphatase, topoisomerase, DNA gyrase; linkers, adaptors, genome mapping and chromosome walking.

Unit - II

Carrier Systems

Basic system of genetic engineering: Vectors in Gene Cloning: Natural - Plasmids, Bacteriophages (λ phage, M13 phage), Phagemids, Cosmids, Fosmids, Tumor inducing plasmids and Root inducing Plasmids. Artificial - PAC, Bacterial Artificial Chromosomes, Yeast Artificial Chromosomes, Human artificial chromosome, Expression Vectors, Shuttle Vectors.

Unit - III

DNA Manipulation Techniques

Purification of genomic DNA from living cells, manipulation of purified DNA; construction of prototype vector pBR ^{322}, cloning strategies. Chemical synthesis of DNA, DNA sequencing methods- chemical degradation, chain termination and automated sequencing.

Unit – IV

Gene Transfer Methods

Natural Methods: Bacterial Transformation, Conjugation, Transposition, Phage Transduction, Agrobacterium Mediated Transfer, Retroviral Transduction. Artificial Methods -Physical Methods: Microinjection, Macroinjection, Biolistic Transformation. Chemical Methods: Calciumphosphate mediated DNA transfer, Use of polyethylene glycol(PEG), Use of DEAE-Dextran(diethyl aminoethyl), Use of liposomes. Electrical Methods: electroporation, electrofusion).

Unit - V

Selection and screening

Selection of recombinants (antibiotics, expression basis - GUS expression), blotting techniques - Southern, Northern and Western Blot. Principles, types and applications of PCR. DNA finger printing - restriction fragment length polymorphism (RFLP); random amplified polymorphic DNA (RAPD); DNA foot printing.

Text Book

1. Primrose S.B., Twyman R.M. and Old R.W., Principles of Gene Manipulation, 7th Edition, University of California, 2006.

References

1. Glick B.R. and Pasternak J., Molecular Biotechnology, ASM Press, USA, 2003.
2. Glover D.M. and Hames, B.D., DNA Cloning I and 2, IRL Press, Oxford University Press, USA, 1995.
3. Sambrook J., Fritsch, E.F., Mariatis J, Molecular Cloning - A Laboratory Manual, 3rd Edition, Cold Spring HAT Laboratory, USA, 2001.
4. Primrose S.B., Molecular Biotechnology, 2nd Edition, Blackwell Scientific Publishers, Oxford, 1994.

CORE COURSE : VIII - IMMUNOLOGY

Semester : 3 **Course Code : P15BT308**
Credits : 5 **Total Hours : 75**

General Objectives

1. To know about the immune system and their functions
2. To know the significance of various immunological disorders and their remedies

Unit - I

Introduction

Historical perspective and overview of Immune system, Haematopoiesis and differentiation; cells of immune system: Haematopoietic stem cells, T-cells, B-cells, Macrophages, Monocytes, Polymorphs, Platelets and Null cells. Immunity: Innate and acquired immunity. Lymphoid organs: Primary lymphoid organs (Thymus, Bone marrow), Secondary lymphoid organs (Spleen, Lymph node, MALT). Theory of clonal selection.

Unit - II

Cellular Responses

T- Cells and B- Cells: Development, maturation, activation and differentiation. Antigen: Properties and Biology. Immunoglobulin: Structure, functions and Classifications. Monoclonal antibodies - Principles and applications; APC's, MHC, antigen processing and presentation, regulation of T and B cell responses.

Unit - III

Infection and Immunity

Injury and Inflammation; Immune response to infections; Complement system; Immunity to - Bacteria, Virus, Fungi, and Parasites; Cytokines; Hypersensitivity; AIDS and Immunodeficiency, resistance and immunization; vaccines.

Unit - IV

Transplantation and Tumor Immunology

Transplantation: Mechanism, Graft rejection, General and specific immunosuppressive therapy; Clinical transplantation; Tumor immunology; Autoimmunity: Autoimmune diseases, diagnosis and treatment.

Unit - V

Immunotechniques

RIA, ELISA, Immunoelectrophoresis, SDS-PAGE, FAC's, Immuno-flourescence, Western Blotting, Immunodiffusion, Immunohistochemistry,
Immunization protocol and procedures

Text Book

1. Janis Kuby J, Immunology, W. H. Freeman & Co., 4th Edition, 2000.

References

1. Abul K. Abbas, Andrew K.Lichtman and Jordan S. Pober, Cellular and Molecular Immunology, 3rd Edition, WB, Saunders Company, 1997.
2. Weir D.M. Ann and Stewart J, Immunology, 8th Edition, Churchill Livingston, New York, 1997.
3. Ivon Roitt, Essential Immunology, 8th Edition, Blackwell Scientific Publication, 1994.

CORE COURSE : IX - MEDICAL BIOTECHNOLOGY

Semester : 3 **Course Code : P15BT309**

Credits : 5 **Total Hours : 75**

General Objectives

1. To know about the genetic disorders caused by the environmental factors and patterns of inheritance
2. To know the mechanism and diagnosis of cancer
3. To understand the handling and processing of clinical samples

Unit – I

Diagnostic Biotechnology

Enzyme Diagnostics –nucleic acid based diagnostics –PCR based diagnostics and Sequencing – Blood Products – Biosensors –types; Biochips

Unit - II

Cancer Diagnostics

Molecular markers-Cancer phenotyping – molecular, immuno and fluorescent based diagnostics FACS-cancer gene therapy – microsatellite and telomeric analysis-FISH- Vaccines-DNA Vaccines and synthetic Vaccines

Unit – III

Pathology

Handling of clinical samples- Precautions and Safety measures- Physical and Chemical examination of body fluids (Blood and Urine)- Types – Colour , Transparency, pH , Specific gravity; Protein, Sugar, Ketone bodies, Bile pigment/salt, Chyle and Blood. Laboratory diagnosis of UTI. Food Poisoning and Food allergy.

Unit - IV

Clinical Biochemistry

Disorders of carbohydrate metabolism and their detection, measurement of glucose in plasma and urine, ADA classification of diabetes mellitus, glucose tolerance test, detection of gestational diabetes and self monitoring of blood glucose.

Unit - V

Clinical Research in Drug Discovery

New Drug Application and Approval - Pharmaceutical Industry – Global and Indian Perspective - Clinical Trial market. Selection of drugs – Threats behind self- medication- Clinical data management, Ethical issue in clinical studies.

Text Book

1. Gupta S.K, Basic Principles of Clinical Research and Methodology, Jaypee Brothers Medical Publishers, 2007.

References

1. Pillai, Biochemistry and Clinical Pathology, CBS Publications, 2012.
2. Stephen Hulley, Outlines and Highlights for Designing Clinical Research: An Epidemiologic Approach, Academic Internet Publishers, 2011.
3. Dan Wood, Daron Smith, Research in Clinical Practice, Springer Publications, 2012.
4. Robert J. Levine, Ethics and Regulation of Clinical Research, 2nd Edition, Yale University Press, 2010.

CORE PRACTICAL : IV - GENE TECHNOLOGY LAB

Semester : 3 **Course Code : P15BT3P4**

Credits : 3 **Total Hours : 75**

General Objectives

1. To gain hands on experience in molecular techniques
2. To become familiar with DNA manipulation

1. Isolation of Genomic DNA from bacteria
2. Agarose gel electrophoresis
3. Restriction digests of DNA
4. Ligation- T^4 DNA Ligase
5. Polymerase Chain Reaction (PCR)
6. RFLP
7. RAPD
8. SDS PAGE
9. Native PAGE
10. Southern Blotting
11. Transformation- Blue and White method
12. Isolation of plasmid DNA

References

1. Brenda D. Spangler, Methods in Molecular Biology and Protein Chemistry, John Wiley and Sons, Ltd., 2002.
2. Sambrook and Russell, Molecular Cloning: A Laboratory Manual, Volumes I – III, Cold Spring Harbor Laboratory, 1989.
3. Ausbel M and Roger Breut, Short Protocols in Molecular Biology, Volumes I & II, 5th Edition, Frederick John Wiley and Sons Inc., 2002.

CORE PRACTICAL : V - IMMUNOLOGY & MEDICAL BIOTECHNOLOGY LAB

Semester : 3 **Course Code : P15BT3P5**

Credits : 3 **Total Hours : 75**

General Objectives

1. To become familiar with basic immunological techniques and applications
2. To acquire skills in identifying pathogens from clinical samples

IMMUNOTECHNOLOGY

1. Blood grouping
2. Differential WBC count
3. Rocket Immunoelectrophoresis.
4. Radial immunodiffusion.
5. Purification & Estimation of IG.
6. Isolation of Lymphocytes from Blood.
7. Western Blotting.
8. Dot ELISA.
9. Pregnancy test.
10. Immunisation.
11. Serum preparation.

MEDICAL BIOTECHNOLOGY

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

References

1. Noel R. Rose, Manual of Clinical Laboratory and Immunology, 6th Edition, 2002.
2. Sambrook and Russell, Molecular Cloning: A Laboratory Manual, Volumes I – III, Cold Spring Harbor Laboratory, 1989.
3. Robert Cruickshank, Medical Microbiology - Guide to the Laboratory Diagnosis and Control of Infection, Volume 1, 12th Edition, Churchill Livingstone Publishers, 1973.
4. Cheever F.S., Laboratory Manual of Microbiology, Pubmed Central, 2006.

ELECTIVE : III - STEM CELL BIOLOGY

Semester : 3 **Course Code : P15BT3:1**
Credits : 4 **Total Hours : 75**

General Objectives

1. To know about stem cell and regenerative biology
2. To learn the molecular mechanisms, applications and social implications associated with stem cell biology.
3. To know the ethical issues on the applications of stem cells

Unit - I

Biology of Embryogenesis and Stem Cells

Genesis of life & perspectives of embryogenesis - Model organisms for developmental studies- Concepts of mammalian development, Gametogenesis & early embryogenesis Organogenesis and developmental plasticity- Concepts on stem cells and historical perspectives -Characteristic features- differentiation and propagation of stem cells.

Unit - II

Differentiation and Types of Stem Cells

Embryonic stem cells & germ stem cells -Fetal-adult's stem cells & cancer stem cells -New generation stem cells -Induced pluripotent stem cells & patient-specific stem cells -Genetically engineered stem cells.

Unit - III

Significance of Stem Cells

Academic research need for stem cells: Biopharmaceutical need for stem cells- Medical (therapeutic) need for stem cells-Stem cells and progenitors for drug testing-Genetically engineered stem cells for drug discovery & gene therapy.

Unit - IV

Applications of Stem Cells

Clinical trials, safety and therapeutic-grade stem cells, stem cell therapy in neurodegenerative disorders, cardiovascular disorders, metabolic/ diabetic/systemic disorders, hematopoietic & autoimmune diseases, organ disorders, reproductive failures, Stem cell preservation in cancer patients

Unit - V
Opportunities and Policy of Stem Cells

Research scope and human resource development , National and global need for stem cell research-therapy & medical tourism, Institutions involved in stem cell research-therapy, Guidelines & SOPs on stem cell research-therapy, Informational resources on stem cells.

Text Book

1. Marshak, Stem Cell Biology, Cold Spring Harbor Symposium Publication, 2001.

References

1. Stewart Sell, Stem Cells Handbook, Humana Press, New York, 2003.
2. Robert Paul Lanza, Essentials of Stem Cell Biology, Elsevier Academic Press, 2006.
3. Krusade Turksen, Adult Stem Cells, Human Press, USA, 2004.
4. Daniel Levitt and Ronald Mertelsmann, Hematopoietic Stem Cells - Biology and Therapeutic Application, Informal Health Care, 1995.
5. Suzanna Holland, Karan and Lauria, The Human Embryonic Stem Cell Debate, MIT Press, 2001.
6. Stem Cells and the Future of Regenerative Medicine, 2001. National Academies Press, USA. http://www.nap.edu/catalog/10195.html
7. Scientific and Medical Aspects of Human Reproductive Cloning 2002. National Academies Press, USA. http://www.nap.edu/catalog/10285.html
8. Cord Blood: Establishing a National Hematopoietic Stem Cell Bank Program.(2005). http://www.nap.edu/catalog/11269.html

ELECTIVE : III - DEVELOPMENTAL BIOLOGY

Semester : 3 **Course Code : P15BT3:2**

Credits : 4 **Total Hours : 75**

General Objectives

1. To know the cellular basis of development
2. To elucidate the early development process of human beings

Unit - I

Basic Concepts of Developmental Biology

General concept of organisms development: Potency, commitment, specification, induction, competence, determination& differentiation; morphogenetic gradients; cell fate& cell lineages; genomic equivalence and cytoplasmic determinants; imprinting. General principles of cell and cell communication in development: cell adhesion and roles of different adhesionmolecules, gap junctions, extracellular matrix, integrins, paracrine factors.

Unit - II

Fertilization, Development and Sex Determination in Humans

Gametogenesis and Sperm & Egg formation; Ultra structure of sperm and ovum, Egg types, egg membrane. Fertilization, Cleavage, Morula, Implantation, Blastulation, Gastrulation, Formation of germ layers, Axis formation - Anterior and Posterior. Sex determination, Chromosomes and Environment.

Unit - III

Organogenesis - I

Organogenesis: Central nervous system and the epidermis and Formation of neural tube, Differentiation of the neural tube, Tissue architecture of the central nervous system, Origin of cutaneous structures. Neural crest cells and axonal specificity, Trunk neural crest, Pattern generation in the nervous system.

Unit - IV

Organogenesis - II

Paraxial and intermediate mesoderm, Somites formation, Osteogenesis, Urogenital system.

Lateral plate mesoderm and endoderm-Heart formation, Digestive tube and its derivatives.

Unit - V

Implications of Developmental Biology

Medical implications of Developmental Biology and Genetic disorders, Environmental assaults on human development, Environmental regulation of animal development and environment as a part of

normal development, Polyphenisms and plasticity, Learning system. Mechanisms of macro evolutionary change, Heterotrophy, Heterochrony and Heterometry.

Text Book

1. Gilbert S.F, Developmental Biology, 9th Edition, Sinauer Associates Inc. Publications, Sunderland, Massachusetts, 2010.

References

1. Alberts B, Molecular Biology of the Cell, 3rd Edition, Garland Science, New York, 2002.
2. Lodish H, Molecular Cell Biology, 4th Edition, W.H.Freeman, New York, 2000.

CORE COURSE : X - ENVIRONMENTAL BIOTECHNOLOGY

Semester : 4 **Course Code : P15BT410**

Credits : 5 **Total Hours : 75**

General Objectives

1. To know the global environmental changes.
2. To know biotechnological methods of handling recent environmental problems like waste water treatment, solid waste management and bioenergy

Unit – I

Ecology and ecosystem

Global environmental changes: Global warming, Green house effect, acid rain, ozone depletion, thermal inversion and photochemical smog. Sources, types, effects of Environmental Pollutions – Water, Air, Thermal, Industrial, oil, Metal Toxicl Hazardous wastes and Radiation- environmental issues, management strategies and safety biotechnological approach for management. Biomagnifications.

Unit – II

Waste water treatment

Aerobic and anaerobic methods of waste water treatment (Primary Secondary and Tertiary) –use of aquatic plants in waste water treatment. Solid waste management. Bio – energy and SCP from waste. Microbial desulphurization of coal recycling and processing of organic residues.

Unit – III

Xenobiotics

Ecological considerations, decay behavior and degradative plasmids; hydrocarbons, substituted hydrocarbons, oil pollution, surfactants, pesticides. Biopesticides integrated pest management. Biodiversity: Biodiversity at global level, species diversity. Biodiversity and its conservation-insitu and exsitu conservation. Loss of biodiversity and its causes.

Unit – IV

Bioremediation

Biosensors in Bioremediation. Biotechnology in pulp and paper industry, Advanced and emerging Biotechnological applications for industrial effluent (tannery and distillery). Pesticide waste disposal, oleophilic fertilizers and use of genetically engineered microbes. Biosorption and Bioaccumulation principles. Giant bacteria and their ecological significance. Seaweeds for removal of heavy metal pollutants. Hazards of genetically engineered microbes plants and animals to the environment.

Unit V

Environmental toxicology

Toxicology – Basic probit analysis concepts – Toxicants – Toxicity, Acute, sub acute, chronic, dose effect, LD 50 and response safe limits. Dose response safe limits. Dose response relationship, graphs, concentration response relationship.

Text Book

1. Alan Scragg, Environmental Biotechnology, Pearson Education Limited, England, 1999.

References

1. Eugene P.Odum, Fundamentals of Ecology, W.E. Saunders Company, London, 1972.
2. Metcalf and Eddy, Wastewater Engineering – Treatment Disposal and Reuse Inc., Tata McGraw Hill, New Delhi,1979.
3. Crosby and Donald G, Environmental Toxicology and Chemistry, Oxford University Press, 1998.

ELECTIVE : IV - BIOTECHNOLOGY MANAGEMENT

Semester : 4 **Course Code : P15BT4:1**

Credits : 4 **Total Hoursvv : 75**

General Objectives

1. To know about the biotechnological management of various industrial, food and agricultural wastes
2. To understand ethical issues that arise in the relationships among life sciences, biotechnology and medicine.

Unit – I

Management of domestic and industrial Wastes

Processing of Fruit and Vegetable wastes, Dairy products, Meat, Poultry and Sea food, Beverage and Fermentation of Industrial wastes.

Unit - II

Processing and Utilization of Grain Milling Industries

Processing and Utilization of Grain milling industries, Spices and Condiments, Sugar and Paper Industrial wastes.

Unit - III

Waste Management by Nanotechnology

Nanotechnology for waste minimization, Nanofiltration, Nanocatalysts, Magnets and Detectors, Electro spinning nanofibres for Water Treatment and Potential risks.

Unit - IV

Environmental Impacts

Pollution prevention, Measurement-COD, BOD, DOC; Control measures, Legal and environmental issues.

Unit - V

Bioethics

Methods in bioethics, Autonomy Organ transplantation, Biobanking, Morality of human embryos and stem cell research; Therapeutic cloning; Genetic screening and enhancement; Animal experimentation; International guidelines.

Text Book

1. Joshi V.K and Sharma S.K, Food Processing Waste Management, New India Publishing Agency, New Delhi, 2011.

References

1. Shaleesha A Stanley, Bioethics, Wisdom Educational Services, Chennai, 2008.
2. Bonnie Steinbock, The Oxford Handbook of Bioethics, Oxford University Press, New Delhi, 2007.
3. Lewis Vaughn, Bioethics, Principles, Issues and Cases, Oxford University Press, New Delhi, 2012.

ELECTIVE : IV BIOSAFETY, BIOETHICS AND IPR

Semester : 4 **Course Code : P15BT4:2**

Credits : 4 **Total Hours : 75**

General Objectives

1. To know about Biosafety and Bioethics
2. To know about intellectual property rights and their implications to biotechnology

Unit - I

Principles of Biosafety

The Cartagena Protocol in Biosafety (CPB, 2000). Advanced Informed Consent, Precautionary Principle, Substantial Substantial Equivalence.GMO Labeling, Containment, Post-market Surveillance and Evolution and Management of Risks arising from the use release of GMOs.

Unit - II

Safety of Food & Animal Feed Derived From GM Crops

Nutritional and Toxicological Difference in the Food chain. Environmental impacts; invasiveness / Persistence; toxicity to wildlife; Development and resistance; New Weed Control Strategies; Horizon ; Changes in agricultural practices; Limitation of Science.

Unit – III

Bioethics

The growing impact of the new genetics on the courts - Integrating DNA Technology into the Criminal Justice System; Genes, Dreams & Reality - the promises and risks of the new genetics; Protecting Genetic Privacy; Gene testing - Pros & Cons. Human Cloning & Human Dignity - an ethical enquiry; Ethical, Legal and Social Issues concerning recent advancements in key areas of biotechnology such as pre-natal diagnostics, GMF etc.

Unit - IV

Patents

IP patents – case studies on patents –Basmati Rice, Turmeric, and Neem, Copyrights and related rights- Trade mark –Industrial designs and integrated circuits – geographical indications- protection at national and international levels- Application procedures.

Unit - V

International Convention relating to intellectual property

Establishment of WIPO mission and activities – History –General agreement on trade and tariff (GATT) Legal Protection of Biotechnological Inventions. Indian IPR legislation commitments to WTO, WTO guidelines

Text Books

1. Trayror Pc, Frederic R and Koch M, Biosafety Board of Trustees, Michigan State University, USA, 2002.
2. Sasson A, Biotechnologies and Development, UNESCO Publications, 1988.

References

1. Paul R C, Situation of Human Rights in India, Efficient Offset Printers, 2000.
2. Belmont TL and Leroy W, Cotemporary Issue in Bioethics, Wards Worth Publishing Co Belmont, California, 1999.
3. Vadakar Praveen, Theories and Practice of Human Rights, Rajat Publication, 2000.

Project

Sem. IV **Code : P16BT4PJ**
Total Hrs. : 300 **Credits : 6**

PG - Non Major Elective Course (NMEC)
(For the candidates admitted from the year 2016 onwards)
(Offered to Students of other Disciplines)

Sem.	Course	Code	Title	Hrs./ week	Credits	Marks		
						CIA	ESA	TOTAL
II	NMEC	P16BT2E1	Human and Environment	4	2	25	75	100

NMEC - HUMAN AND ENVIRONMENT

Semester : II **Course Code : P16BT2E1**
Credits : 2 **Total Hours : 60**

General Objectives

1. To know the deleterious effects produced by human beings to the society.
2. To understand the various impacts of global environmental changes.
3. To know about the different environment and health related issues and management strategies.

Unit - I

Global Climatic and Environmental Changes

The human species - distribution and tolerances - body temperature and thermoregulation - response to high temperature, response to cold stress, high altitude. People and environment - overcoming oxygen scarcity, circadian rhythms - nature and control, jet lag and shift work, Man in space - space food, water in space.

Unit - II

Pollution and Environmental Deprivation

Pollution of air, water, soil and their deleterious effects- Acid rain- Global warming; Transfer of harmful compounds through ecosystems; Control and remedies of pollution- Eco friendly cars, biofuels, Bio gas. Solid waste Management: Causes, effects and control measures of urban and industrial wastes recovery and utilization of resources.

Unit - III

Food Habits in Man

Environment risks of direct and indirect food additives, food colors and other contaminants, food fads and fallacies. GM foods - definition, why GM foods, potential risks to human health, risk assessment for the environment, GM foods in future.

Unit - IV

Environment and Human Health

Stress and heart disease, junk food and obesity, psychotic behavior and their outcomes such as dementia, depression, schizophrenia. Smoking and man - hazardous effects of smoking.

Unit - V

Biology and Future of Mankind

New application of biological sciences towards human welfare - Human gene therapy; Human population growth ¬Control of human fertility, Possible means of birth control, Invitro fertilization, Ethical considerations Eugenics, Guarding the genetic quality of man. Future of Homo sapiens

Text Books

1. Agarwal, K.C., Environmental Biology, Nidi Publ. Ltd., Bikaner, 2001.
2. Odum, E.P. Fundamentals of Ecology, WB, Saunders Co., USA, 1971.
3. John Adds, Erica Larkcom, Ruth Miller; The organism and the environment, 2nd Edition, Thomas Nelson and Sons Ltd., 1997.

References

1. Alan Scragg, Environmental Biotechnology, Pearson Education Limited, England, 1999.
2. Metcalf and Eddy, Wastewater engineering –Treatment Disposal and Reuse, Tata McGraw Hill, New Delhi, 1979.
3. Schurmann, G.A., Ecotoxicology, John Wiley & Sons, 1998.
4. Crosby, Donald G., Environmental Toxicology and Chemistry, Oxford University Press, 1998.