

**MANONMANIAM SUNDARANAR UNIVERSITY**

**TIRUNELVELI**

UG COURSES – AFFILIATED COLLEGES

**B.Sc. BIOTECHNOLOGY**

(Choice Based Credit System)

(with effect from the academic year 2016-2017 onwards)

Sem	Pt I/II/ III/I VV/ VI	Sub No.	Subject Status	Subject Title	Hrs/ week	Cre dits	Marks				
							Maximum			Passing minimum	
							Int.	Ext.	Tot.	Ext.	Tot.
V	I	33	Core - 7	Genetic engineering	4	4	25	75	100	30	40
	II	34	Core - 8	Plant biotechnology	4	4	25	75	100	30	40
	III	35	Elective - 1	Intellectual Property Rights (or) Clinical research	5	5	25	75	100	30	40
		36	Elective - 2	Genomics (or) Nano Biotechnology	5	5	25	75	100	30	40
		37	Practical -5	Genetic engineering	3	-	50	50	100	20	40
		38	Practical - 6	Plant Biotechnology	3	-	50	50	100	20	40
		39	Practical - 7	Bioinformatics	2	-	50	50	100	20	40
	IV	40	Skill Based subject (Common)	Personality Development/ Effective Communication/ Youth Leadership	4	4	25	75	100	30	40
				Subtotal	30	22					

VI	I	41	Core - 9	Animal Biotechnology	6	4	25	75	100	30	40
	II	42	Core - 10	Stem Cell Technology	6	4	25	75	100	30	40
	III	43	Core - 11	Bioprocess Technology	5	4	25	75	100	30	40
		44	Elective - 3	Basic Bioinformatics (or) Biosafety and Bioethics (or) Applied Biotechnology	5	5	25	75	100	30	40
		45	Practical – 8	Animal biotechnology	3	4	50	50	100	20	40
		46	Practical – 9	Stem Cell Technology	3	4	50	50	100	20	40
		47	Practical - 10	Bioprocess Technology	2	4	50	50	100	20	40
					Subtotal	30	29				

## GENETIC ENGINEERING

### Unit I

History and scope of genetic engineering, restriction enzymes, ligases, alkaline phosphatase , polynucleotidekinase, terminal nucleotidyl transferase, DNA polymerases, Taq DNA polymerase, RNase, reverse transcriptase, linkers, adapters, oligonucleotide primers and homopolymer tailing,

### Unit II

Gene cloning vectors-Plasmids, construction of PBR<sup>322</sup>, Bacteriophage vectors, phagemids, cosmids, yeast vectors and expression vectors in prokaryotic and eukaryotics, cloning strategies-gene library construction , screening of gene library,

### Unit III

Analyzing DNA and protein sequences, polymer chain reaction, inverse PCR, RT-PCR, changing genes-site directed mutagenesis, phage display, nucleic acid microarrays, northern blot, uses of online tools-web cutters and vector NT1, SAGE (serial analysis of gene expression).

### Unit IV

Expression strategies for heterologous genes- expression in bacteria, yeast, insect, and insect celllines, mammalian cell lines and in plants. Processing of recombinant proteins, purification and re-folding, characterization of recombinant proteins, stabilization of proteins.

### Unit V

Transposon tagging, Role of gene tagging in gene analysis, transgenic animals (mice, cattle, fish), transgenic plants (herbicide tolerance, delayed ripening) antisense RNA technology, human gene therapy.

### References

1. Primrose, S B, 1994, Molecular Biotechnology (2<sup>nd</sup> ED) Blackwell Scientific Publishers, Oxford.
2. James D. Watson. Recombinant DNA (2001). Scientific American Books. USA
3. Benjamin Lewin, Genes-V111, Oxford University press.
4. Glover, D.M and B.D Hames, DNA cloning1-4 (2006) Oxford University press.

## PLANT BIOTECHNOLOGY

### Unit I

Plant tissue culture – History – Concept of totipotency – Principle - Laboratory organization – Sterilization techniques – Media preparation – Types of media – MS media, Nitsh media and Gamborgs media – Plant growth regulators.

### Unit II

Callus culture – Suspension culture - Organogenesis. Plant micro propagation, Single cell culture, Virus elimination and Shoot tip cultures. Role of tissues culture in agriculture, forestry – Horticulture – Haploid plant production – Virus free plants.

### Unit III

Embryo culture - Isolation, culture and fusion of plant protoplasts. Somaclonal variation, Somatic embryogenesis – Molecular markers – Types and uses – Plant genome projects – Arabidopsis - Cryopreservation and germplasm conservation.

### Unit IV

Plant genome organization, Gene silencing in crop plants, Gene transfer methods. Current status of plant transformation technologies. Production of therapeutic antibodies and vaccines in plants – Agrobacterium tumefaciens and Rhizogenes transformation – Secondary metabolites – Types and uses - Invitro productions.

### Unit V

Genetic engineering of crop plant for insect resistance (Bt –cotton), fungus resistance, virus resistance, drought, cold and saline resistance. Improvements of crop yield, quality and nutritions - Transposable elements - Procedures involved in commercialization of transgenic crops.

### References

1. J. Hammond, P McGarvey and V. Yasibov (Eds). Plant Biotechnology Springer Verlag 2000.
2. T.J. Fu, G. Singh and W. R. Curtis (Eds). Plant Cell and Tissue culture for the production of food ingredients. Kluwer Academic / Plenum press. 1999.
3. H.S. Chawla: Biotechnology in crop improvement. International Book distributing company 1998.
4. R. J. Henry: Practical Application of Plant Molecular Biology. Chapman and hall. 1997.
5. P.K. Guptha. Elements of Biotechnology Rastogi and Co, Meerut, 1996.
6. U. Sathyanarayanan, Biotechnology, Books and allied (P) Ltd.2005.
7. S.S. Bhojwani and M.K. Razdan, Tissue culture Theory and Practice, 2004.
8. Paul Christou and Harry Klee (2004) Hand book of Plant Biotechnology. Vol. I & II John Wiley & Sons.

## **INTELLECTUAL PROPERTY RIGHTS**

### **Unit I**

Introduction – Invention and Creativity – Intellectual Property (IP) – Importance – Protection of IPR. Why IPR is necessary, TRIPS and IPR, IPR – National and International scenario, IPR protection of wild life forms. Patents of Biotechnology in India.

### **Unit II**

Ip – Patents – Copyrights and related rights – Trade Marks and rights arising from Trademark registration – Definitions – Industrial Designs and Integrated Circuits – Protection of Geographical Indications at National and International levels – Application Procedures.

### **Unit III**

International convention relating to Intellectual Property – Establishment of WIPO – Mission and Activities – History – General Agreement on Trade and Tariff (GATT).

### **Unit IV**

Indian Position Vs WTO and Strategies – Indian IPR Legislations – Commitments in WTO Patent Ordinance and the Bill – Draft of a National Intellectual Property Policy – Present against unfair competition.

### **Unit V**

Case studies on – Patents (Basumati rice, turmeric, neem, etc.) – Copyright and related rights – Trade Marks – Industrial Design and Integrated circuits – Geographic indications – Protection against unfair competition.

### **References**

1. Subbaram N.R. “Handbook of Indian Patent Law and Practice”, S. Viswanathan Printers and Pulishers Private Ltd.
2. Eli Whitney, United States Patent Number. 72X, Cotton Gin, March 14, 1794.
3. Intellectual Property Today: Volume 8, No.5, May 2001, ([www.iptoday.com](http://www.iptoday.com)).
4. Using the internet for non-patent prior art searches, Derwent IP matters, July 2000. [www.ip.atters.net/features/000707\\_gibbs.html](http://www.ip.atters.net/features/000707_gibbs.html).

**Major Elective –I (B)**

**CLINICAL RESEACH**

**Unit I**

Introduction to drug discovery and drug development, basic pharmacology and clinical research. Basic knowledge about receptors, drugs, pharmacodynamic, pharmacokinetic (ADME), drug interactions, clinical research. Introduction to pharmacoeconomics.

**Unit II**

New drug discovery process – purpose, main steps involved in new drug discovery process, timelines for each steps, advantages and purpose of each steps, ethics in clinical research, unethical trials, thalidomide tragedy.

**Unit III**

Clinical trials - phase I, II, III, IV trials, Post marketing surveillance-methods – principles of sampling – inclusion and exclusion criteria – methods of allocation and randomization – informed consent process (in brief) – monitoring treatment outcome – termination of trial – safety monitoring in clinical trials

**Unit IV**

Preclinical toxicology: General principles, systemic toxicology (single dose and repeated dose toxicity studies), carcinogenicity, mutagenicity, teratogenicity, reproductive toxicity, local toxicity, genotoxicity, animal toxicity requirements.

**Unit V**

Basic terminology used in clinical research, Types of clinical trials – single binding, double binding, randomized trials, cross over design and their examples, interventional study, ethical committee and its members, Institutional ethical committee/Independent ethical committee, Data management in clinical trials.

**References:**

1. Basic and Clinical Pharmacology, Prentice Hall, International, katzung, B.G.
2. Clinical Pharmacology. Scientific book agency, Laurence, D.R and Bennet P.N.
3. Clinical Pharmacy and Therapeutics. Herfindal E.T., Hirschman J.L., Williams and Wilkins.
4. Drug Interaction, Kven Stockley, Hamsten.

**Major Elective –II (A)**

**GENOMICS**

**Unit I**

Genome – overview of genome, sequence of genome acquisition and analysis – homologies – SNPs – Genetic analysis, Linkage mapping, High Resolution Chromosome mapping and analysis – Physical mapping, YAC, Hybrid mapping, strategies, Sequence Specific Tags (SST), Sequence Tagged Sites (STS), ISH, FISH, RFLP, RAPD.

**Unit II**

DNA sequencing – methods, Maxam and Gilbert method, ladder, Fluorescent, Shot gun, Mass Spectrometry, automation sequencing – Find gene mutations, implications of DNA – Sequencing and sequencing genomes.

**Unit III**

Genome Data Bank, metabolic pathway data – construction and screening of cDNA, libraries and microarrays – Applications of DNA arrays – PCR – Variations in PCR – Gene Disruptions – Sage and Sade, Pharmacogenomics.

**Unit IV**

Protein sequence Analysis – introduction – sequence data banks – WBRF – PIR – SWISSPROT – databases, data mining – algorithms of Proteomics and its applications - Protein Expression profiling – Protein protein interactions – Protein modifications. Automation - nucleic acid data bank – EMBL Nucleotide sequence data bank – AIDS virus sequence data bank – RNA data bank.

**Unit V**

Tools for data bank – pairwise alignment – Needleman and Wunsch algorithm - Smithj waterman – Multiple alignment – CLUSTRAL – PRAS –BLAST – FAST, Algorithms to analyse sequence data – PDB, Cambridge structure data base (ISD), 2d electrophoresis, IEF, HPLC, Protein digestion technique, Mass spectrometry, MALDI, TOF, peptides, mass fingerprinting.

**REFERENCE**

1. Principles of Proteomics, R.M. Twyman
2. Handbook of Proteomic Method, P. Michael Conn
3. Proteomics – Introduction to methods and applications, A. Kraj and J. Silberring
4. Genomics, Cantor and Smith
5. Biochemistry, L. Stryer
6. Bioinformatics computing, Bergeron
7. Computational Molecular Biology, P. Clote and R. Backofen
8. Bioinformatics, Biocomputing and Perl: An introduction to Bioinformatics computing skills, Michad Moorhiase and Paul Barry John

**Major Elective – II (B)**

**NANOBIOTECHNOLOGY**

**Unit I**

Fabrication and characterization of nanostructures - Introduction – Scientific revolutions –Time and length scale in structures – Definition of a nanosystem, Chemical methods, Physical methods, Microbial production of inorganic nanoparticles, Characterization: UV Spectroscopy, FTIR, SEM, TEM, AFM,

**Unit II**

Nano materials - Classification based on dimensionality-Quantum Dots, Wells and Wires- Carbon-based nano materials (buckyballs, nanotubes, graphene)– Metal based nano materials (nanogold, nanosilver and metal oxides) - Nanocomposites- Nanopolymers – Nanoglasses –Nano ceramics.

**Unit III**

Biology inspired concepts - Protein based nanostructures building blocks and templates, DNA based nanostructures – Topographic and Electrostatic properties of DNA and proteins, Use of DNA molecules in nanomechanics and nanocomputing

**Unit IV**

Application of Nanoparticles - Introduction to bio sensors and tissue engineering , Targetted nanoparticles for drug delivery, Nanotechnology in agriculture – Fertilizer and pesticides, food, electronics, fabric, solar cells, fabric Future of Bionanotechnology.

**Unit V**

Biomaterials - Classification of biomaterials – Comparison of properties of some common biomaterials - Effects of physiological fluid on the properties of biomaterials – Biological responses (extra and intra vascular system) – Metallic, Ceramic and Polymeric implant materials.

**References**

1. Nabok A., “Organic and Inorganic Nanostructures”, Artech House, 2005.
2. Dupas C., Houdy P., Lahmani M., “Nanoscience: Nanotechnologies and Nanophysics”, Springer-Verlag Berlin Heidelberg, 2007.
3. Rolf E. Hummel, “Electronic Properties of Materials”, 4th Ed., Springer, New York, 2011.
4. Silver F. and Dillion C., “Biocompatibility: Interactions of Biological and Implantable Materials”, VCH Publishers, New York, 1989



**Major Practical -5**

**GENETIC ENGINEERING**

1. DNA isolation - from Plant cell, Animal cell (goat liver), & Microbes
2. Isolation of RNA from Yeast
3. Plasmid DNA isolation
4. Gel electrophoresis
5. Digestion of plasmid DNA with restriction digestion
6. Ligation of DNA fragment
7. Elution of DNA from agarose gel electrophoresis
8. Polymerase Chain Reaction
9. Gel documentation & photography
10. Bacterial transformation
11. RFLP and RAPD mapping
12. Southern blotting technique

**Major Practical - 6**

**Plant Biotechnology**

1. Organization of tissue culture laboratory
2. Sterilization of plant materials
3. Preparation of media
4. Micropropagation
5. Callus establishment
6. Isolation of chloroplast from plant cells
7. Isolation of single cells from intact plant organs
8. Synthetic seeds
9. Isolation of protoplast from plant cells
10. Cell suspension culture
11. Acclimatisation

**Major Practical -7**

**Bioinformatics**

1. Retrieval of nucleotide sequence
2. Retrieval of protein sequence
3. BLAST – pairwise sequence alignment
4. FASTA – pairwise sequence alignment
5. Clustal omega/W
6. Multiple sequence alignment of nucleotide and phylogenetic analysis
7. Primer designing
8. Multiple sequence alignment of protein and phylogenetic analysis
9. Visualization of structure database- RASMOL, PDB VIEWER

Submitting DNA sequence in the database

## ANIMAL BIOTECHNOLOGY

### Unit 1

Introduction to animal biotechnology, Animal cell production and culture of animal cells, Development and maintenance of cell lines, continuous cell lines, culture media, preparation of various culture media and sterilization, storage, suspension culture Embryo culture, teratogenesis, teratomas. Cell culture in laboratory, large scale cultures, applications of animal cell cultures.

### Unit II

Genetic engineering in animals-transformation of animal cells, cloning vectors and expression vectors and animal viral vectors. Transgenic animals- improving important genes, production of recombinant proteins, immunotoxins, vaccines, hybridoma technology, Molecular and cellular biology of fertilization.

### Unit III

Integrated pest management- pest management using juvenile hormone analogues, pheromones and genetic manipulation- silkworm and fish as bioreactors, Baculoviruses in biocontrol and foreign gene expression- therapeutic, reproductive cloning.

### Unit IV

Biotechnology in aquaculture ( Ploidy induction, Gynogenesis, Androgenesis and Transgenic fishes). Animal husbandry (*In vitro* fertilization, gamete selection, embryonic sex selection, embryo manipulation, Demi embryos and embryo transfer). Animal cloning- Cryobiology, Stem cell – Isolation, culture and its applications.

### Unit V

Mammalian embryo fusion- Allopheny, Use of nucleic acid probes and antibodies in clinical diagnosis and tissue typing. Mapping of human genome, Role of RFLP, DNA fingerprinting and PCR in forensic science, gene therapy types and their applications, Social , ethical and legal issues in biotechnology.

### References

1. Biotechnology- Sathyanarayana U, (2008), Books and Allied (P) Ltd
2. Animal Biotechnology- R.Sasidhara, MJP publishers, 2006
3. Animal Biotechnology-M.Ranga, Studam publishers, 2006.
4. A text book of Biotechnology. R.C Dubey: S.Chand Co Ltd.

## STEM CELL TECHNOLOGY

### Unit I

Stem cell basics- stem cells, embryonic stem cells, embryonic germ cell, bone marrow stem cell, adult stem cell- Differentiation- Introduction to concept in stem cell biology (renewal, potency etc) – Stem cell characterization – isolation and characterizations – markers and their identifications- Growth factors, requirements and maintenance in culture.

### Unit II

Hematopoietic stem cell- Induced pluripotent stem cell – Epigenetic memory of IPS cells- Early embryonic development- lymphoid cell maturation and differentiation – Cell cycle regulators in stem cells – Molecular mechanisms of self renewal- pluri / multipotency and lineage differentiation- Molecular basis of pluripotency and Stem cell niche.

### Unit III

The Human Umbilical cord- a source of stem cells- Isolation of mesenchymal stem cell – *in vivo* application of UCSC- cord blood stem cells transplantation- Advantages and disadvantages – Cord blood banking.

### Unit: IV

Generation and manipulation of mouse embryonic stem cells- Generation and manipulation of human embryonic stem cell – Animal models of regeneration (Hydra, planarian, earthworm, zebra fish)

### Unit V

Cancer stem cell- origin of cancer stem cell, impact of cancer stem cell, concept of cancer therapy- Epigenetics and reprogramming in stem cell biology- Stem cell gene therapy- Stem cell therapy for neurodegenerative diseases- Stem cell therapy for cardiac regeneration- clinical cell transplantation for leukemia- Ethical issues of stem cell biology.

### References

1. T.J. Kindt, R.A. Goldsby and B.A. Osborne, Kuby, Immunology, 2007, W.H. Freeman and Company.
2. P. Delves, S. Martin, D. Burton and I. Roitt, Roitt's Essential Immunology, Latest Edition, 2006, Wiley – Blackwell.
3. A.K.Abbas, A. Lichtman and J.S. Pober, Cellular and Molecular Immunology, 2000, W.B. Saunders Company.
4. C.A. Janeway, Jr. P. Travers, M. Walport and M.J. Sclommmchik, immunology, 2001. Garland Science.

## BIOPROCESS TECHNOLOGY

### Unit I

Fundamentals of Bioprocess engineering: Introduction of bioprocess, Media design and usage in fermentation, Types of media, composition of media – carbon sources, nitrogen sources, vitamins, mineral, inducer, precursors and inhibitors. Microbial growth, isolation and preservation and maintenance of industrial microorganism, Inoculum development: Development of inoculum for yeast, bacteria, mycelia and fungal processes, Aseptic inoculation of the fermentor.

### Unit II

Sterilization methods: Moist, heat, dry heat, flame, filter, gas, HTST, Treatment: continuous, pasteurization, batch sterilization, continuous sterilization, filter sterilization. Microbial growth kinetics: Factors affecting microbial growth, fermentation kinetics,

### Unit III

Bioreactor : Introduction to bioreactor, Batch and fed batch reactor, continuous reactor, solid state and submerged, aerobic and anaerobic fermentation, mixed microbial population, immobilization of cells and co immobilization, immobilized reactor, Design of bioreactor: construction of material, Basic components – Agitator, aerator, valves, seals, stirrer, glands, measurement and control of parameters, pH ,Do, gas, analysis, control pathway, computer in controlling, Air lift, stirred tank, tower, fluidized bed, packed bed, pulsed filed, Photoreactor.

### Unit IV

Downstream processing: Biomass removal, separation of microbial cells and solid matters, centrifugation, sedimentation, flocculation, microfiltration, Disintegration of microorganism : Sonification, bead mills, homogenizers, chemical lysis, enzymatic lysis, membrane based purification, ultrafiltration, reverse osmosis, dialysis, Chromatography: size , charge, shape, hydrophobic interaction, Drying :spray driers, drum driers, freeze dries.

### Unit V

Microbial products in pharma, food and agri, production and harvest , recovery and use, enzymes, antibiotics : ( Pencillin, tetracycline, streptomycin) Vitamin (B2 & B12) Aminoacid (Lysine, glutamic acid, arginine, threonine) Organic solvents (acetone, butanol, ethanol, glycerol) Organic acid ( acetic acid, citric acid, latic acid) use of microbes in mineral beneficiation recovery.

### References

1. Principles of Fermentation Technology by P.F. Stanbury and A. Whitaker, Pergamon Press, 2<sup>nd</sup> Edition, 2005.
2. Industrial Microbiology by presscott anf Dunns 4<sup>th</sup> edition edited by Gerald reed, Chapman and Hall Publications, 2007.
3. Introduction to Biochemical engineering by D.G. Rao, McGraw- Hill Publications, 1<sup>st</sup> Edition,

**Major Elective –III (A)**

**MAJOR ELECTIVE (Select any one)**

**BASIC BIOINFORMATICS**

**Unit I**

Bioinformatics - an overview, Scope and applications. Introduction to computers, file management, Algorithm- definition and examples- Types of Algorithm-iterative, recursive, fast and slow algorithms.

**Unit II**

DNA databank--the EMBL nucleotide sequence data bank, The protein sequence database-the NBRI-PIR database macro molecular structures- hierarchy in structure, Ramachandran map – peptide data bank, enzyme databases-cloning vector data bases.

**Unit III**

In Data mining, Data ware housing, BLAST, FASTA algorithm to analysis sequence data. Pair-wise alignment and Mutiple alignment of nucleic acids and protein sequences, CLUSTALW

**Unit IV**

Primer Designing, degenerative primers, calculation of annealing temperature, Cytochrome C oxidase gene sequencing, 16S RNA sequencing, complementary & reverse complementary strands.

**Unit V**

Structure prediction of RNA and Protein, RASMOL, Concepts of structure modeling and stability computation-combinational, Drug design, modeling and threading. Access of web based bioinformatics tools. Principle and types of Molecular docking.

**References**

1. Introduction to computers – Balaguruswamy
2. Vittal R. Srinivas, " BIOINFORMATICS : A MODERN APPROACH" , 2005, ISBN : 978-81-203-2858-7, published by PHI Learning Private Limited, New Delhi.
3. Andreas D.Baxevanis, B.F. Francis Ouellette, "Bioinformatics - A Practical Guide to the Analysis of Genes and Proteins", Third Edition, 2005-2006, ISBN: 978-81-265-2192-0, published by John Wiley & Sons INC., U.K.

**Major Elective –III (B)**

**BIOSAFETY AND BIOETHICS**

**Unit I**

Biotechnology – Society, Risks, Ethics and Patenting. Benefits of biotechnology,ELSI of Biotechnology, Recombinant therapeutic products for human and health care. Genetic modifications, recombinant foods, safety of GM foods. Release of genetically engineered organisms- Human embryonic stem cell research – cloning. Social issues – Public opinions against the molecular technologies

**Unit II**

Patents – Basic of Patentability-Non Patentable Inventions- Patent Application – Producer in India – Treaties and conventions of patents – Patent Cooperation Treaty – TRIPS and Pharmaceutical Industry- issues and prospects. Other Forms of IPR : Copyright- Trade Mark – designs – Know how – Patenting of biotechnology products and processes.

**Unit III**

Biosafety – definitions- biosafety level, framework of biosafety regulation I India, structure and functions of committees, DBT guidelines on biosafety in conducting research in biology/biotechnology- Regulation of Genetically modified Organism in India- Biosafety regulation for transgenic plants and animals – labeling of GM foods.

**Unit IV**

Bioethics – definition – Bioethics of IPR- ethical in biotechnology-animal ethics Guidelines for use of lab animals in medical colleges- Licensing of animal house- Human cloning- ethical issues- Ethical clearance norms.

**Unit V**

Ethical issues – ethical issues against the molecular technologies, Bioethics- Necessity of Bioethics, different paradigms of bioethics – National & International. Legal issues- Legal actions taken by countries for use of the molecular technologies.

**References**

1. Biosafety, Traylor, Fredric & Koch, 2002. Michigan State University Pub., USA
2. Contemporary issues in Bioethics, Beauchamp & Leory, 1999. Wardsworth Pub. Co. Belmont, California
3. Manual of patent practice and procedure. IRP India, 2005. Ministry of commerce and industry, New Delhi. PP 163.
4. Biotechnology and safety assessment, John A. Thomas, 2004. pp 333.



**Major Elective –III (C)**

**APPLIED BIOTECHNOLOGY**

**Unit I**

Biogas production (biomethanation). Production of bio ethanol from sugar, molasses, starch and cellulosic materials. Ethanol recovery, microbial production of hydrogen gas, biodiesel from hydrocarbons.

**Unit II**

Yeast- Yeast tablets, Penicillium, culture and purification of single cell protein (scenedesmus, spirulina), Spirulina tablets, Bamboo – paper, Teak – timber, *Acacia arabica* – gum, Asafoetida – resin, *Acacia catechu* – kath.

**Unit III**

Preparation of products viz., fish / prawn pickle, fish wafers, prawn chutney powder, fish soup powder, fish protein hydrolysate, fish stacks, fillets, fish curry, mussel products, marinated products.

**Unit IV**

By products, Production of chitin, chitosan and glucosamine. Algal products – agar, liquid biofertilizer, hydrochloride from shrimp shell waste. Preparation of fish silage. Uses of silage. Isingless, shark fin rays, gelatin from fish waste, Amebrgris, benche-de-mer, squaline, fish meal and oil.

**Unit V**

Medical transcription: Introduction, ethics and legal issues, Abbreviation used in medicines. Prefixes, suffixes, surface marking, positional orientation. Generic names & pharmacological classifications. Common medicines & drugs. Use, importance & application of medical transcription.

**References**

1. Biogas Technology – B.R. Veena (Ashish Pub. House)
2. Industrial Microbiology by G.Reed (Ed), CBS Publishers (AVI Publishing Co)
3. Biology of Industrial Microorganisms by A.L. Demain
4. Fish Processing Technology – T.K.Govindan
5. Fish Processing Technology – Ed, K. Gopakumar
6. Stedman's Medical Terminology, Stedman's, Charlotte Creason RHIA, 2010.

**Major Practical -8**

**ANIMAL BIOTECHNOLOGY**

1. Animal tissue culture
2. Preparation of tissue culture medium and membrane filtration
3. Cell counting and cell viability
4. Measurement of doubling time
5. Preparation of metaphase chromosomes from cultured cells
6. Isolation of DNA from animal cells
7. Demonstration of apoptosis by DNA laddering
8. Handling of lab animals

**Major Practical -9**

**STEM CELL TECHNOLOGY**

1. Culturing of Earthworm.
2. Dissection of earthworm and observation of internal organs.
3. Identification of different cells in the celomic fluid of earthworm.
4. Identification of different cells in the skin of earthworm.
5. Anterior regeneration- amputation at 8<sup>th</sup> segment, observation and image documentation of regeneration kinetics for 10 days minimum.
6. Posterior regeneration- amputation at 30<sup>th</sup> segment, observation and image documentation of regeneration kinetics for 10 days minimum.

**Major Practical -10**

**BIOPROCESS TECHNOLOGY**

1. Isolation of useful microorganism from natural source
2. Pure culture and mixed culture
3. Production of Enzymes
4. Production of antibiotics
5. Optimization of media for enzyme production
6. Immobilization of microbial enzymes
7. Wine and Alcohol production
8. Down streaming processing: product recovery, centrifugation, chromatography – Thin layer chromatography, crystallization