

**SRI DHARMASTHALA MANJUNATHESHWARA COLLEGE, UJIRE-574240**

**(Autonomous)**

**(Re-Accredited by NAAC at 'A' Grade with CGPA 3.61 out of 4)**



**DEPARTMENT OF POSTGRADUATE STUDIES AND  
RESEARCH IN BIOTECHNOLOGY**

**SYLLABUS**

**(Choice Based Credit System)**

**(With effect from 2019-20)**

**Approved in the BOS Meeting held on 04<sup>th</sup> Sept 2019**



## PREAMBLE

### **Revision of syllabus for the two years Master Degree programme in Biotechnology**

Board of Studies in Biotechnology has revised and prepared the Syllabus (CBCS based) for the Biotechnology course in its meeting held on 30<sup>th</sup> July 2016 based on the UGC letter (Ref, No. MU/ACC/CR.38/CBCS (PG)/2015-16 dated 05-05-2016) to offer Hard Core, Soft Core and Open Elective course papers with credits amounting to 92 credits , for the entire programme

The BOS has prepared the syllabus by adopting the pattern of 14 hard core and 11 soft core along with one project. Total credits for hard core is 52, soft core 30, project 4 and 6 credits are for open elective.

Detailed syllabus is prepared for all the four semesters

#### **Course/Credit Pattern**

Semester	Hard Core Theory	Soft Core Theory	Hard Core Practical	Soft Core Practical	Open Elective	Project	Total Credits
First	12	3	08	-----	-----	-----	23
Second	08	06	04	03	03*	-----	21+03*
Third	08	06	04	03	03*	-----	21+03*
Fourth	04	06	04	03	-----	04	21
Total	32	21	20	09	06*	04	86 + 06* = 92

Total credits from all the four semesters =  $86+6^*= 92$

Total hard core credits =  $52 + 4 = 56$

Project Credits = 04

Total Soft core credits =  $09+ 21 = 30$

\*Open elective credits = 6

Open electives are given grades and they are not included in the CGPA



In the first semester two soft core papers are offered and the student has to opt for any one. In the second, third and fourth semesters three soft core papers are offered in each semester and the student has to opt for any two.



**SDM COLLEGE (AUTONOMOUS), UJIRE**

**M.Sc. BIOTECHNOLOGY,**  
**CONTENT OF THE COURSE AND SCHEME OF EXAMINATION**

**FIRST SEMESTER**

Course Code	Course Title	Teaching hours per week	Credits	Marks		Total
				IA*	Exam	
<b>HARD CORE COURSES - THEORY</b>						
BTH401	Biochemistry	4	4	30	70	<b>100</b>
BTH402	Microbiology	4	4	30	70	<b>100</b>
BTH403	Cell biology	4	4	30	70	<b>100</b>
<b>SOFT CORE COURSES- THEORY (CHOOSE ANY ONE)</b>						
BTS404	Molecular Genetics	3	3	30	70	<b>100</b>
BTS405	Bio analytical techniques					
<b>PRACTICALS</b>						
BTP406	Biochemistry & Microbiology	6	4	30	70	100
BTP407	Cell biology & Molecular Genetics	5	4	30	70	100
	OR	5	4	30	70	100
BTP407	Cell biology & Bio analytical techniques					
Total			<b>23</b>			<b>600</b>

**IA consists of Seminars, Assignments, Internal Tests**



**SECOND SEMESTER**

Course Code	Course Title	Teaching hours per week	Credits	Marks		Total
				IA*	Exam	
<b>HARD CORE COURSES - THEORY</b>						
BTH451	Molecular biology	4	4	30	70	<b>100</b>
BTH452	Genetic Engineering	4	4	30	70	<b>100</b>
<b>SOFT CORE COURSES - THEORY (CHOOSE ANY TWO)</b>						
BTS453	Metabolism	3	3	30	70	<b>100</b>
BTS454	Enzymology					
BTS455	Biostatistics & Bioinformatics	3	3	30	70	<b>100</b>
<b>PRACTICALS</b>						
BTP456	Molecular biology & Genetic Engineering	6	4	30	70	100
BTP457	Metabolism & Ezymology	5	3	30	70	100
	OR		3	30	70	100
BTP457	Metabolism & Bioinformatics	5	3	30	70	100
<b>OPEN ELECTIVES</b>						
BTE458	Applications of Biotechnology	3	3	30	70	<b>100</b>
BTE459	Recombinant DNA Technology					
Total			<b>21</b>			<b>700</b>

**IA consists of Seminars, Assignments, Internal Tests**



### THIRD SEMESTER

Course Code	Course Title	Teaching hours per week	Credits	Marks		Total
				IA*	Exam	
<b>HARD CORE COURSES - THEORY</b>						
BTH501	Plant Biotechnology	4	4	30	70	<b>100</b>
BTH502	Animal Biotechnology	4	4	30	70	<b>100</b>
<b>SOFT CORE COURSES - THEORY (CHOOSE ANY TWO)</b>						
BTS503	Bioprocess Technology	3	3	30	70	<b>100</b>
BTS504	Microbial Technology					
BTS505	Nano Biotechnology	3	3	30	70	<b>100</b>
<b>PRACTICALS</b>						
BTP506	Plant Biotechnology & Animal Biotechnology	6	4	30	70	100
BTP507	Bioprocess & Microbial Technology	5	3	30	70	100
	OR					
BTP507	Bioprocess Technology & Nano Biotechnology	5	3	30	70	100
<b>OPEN ELECTIVES</b>						
BTE508	Industrial Biotechnology	3	3	30	70	<b>100</b>
BTE509	Bioentrepreneurship					
Total			<b>21</b>			<b>700</b>

**IA consists of Seminars, Assignments, Internal Tests**



**FOURTH SEMESTER**

Course Code	Course Title	Teaching hours per week	Credits	Marks		Total
				IA*	Exam	
<b>HARD CORE PAPERS – THEORY</b>						
BTH551	Immunology	4	4	30	70	<b>100</b>
<b>SOFT CORE COURSES - THEORY (CHOOSE TWO ONE)</b>						
BTS552	Environmental Biotechnology	3	3	30	70	<b>100</b>
BTS553	Agricultural Biotechnology					
BTS554	Food Biotechnology	3	3	30	70	100
<b>PRACTICALS</b>						
BTP555	Immunology	6	4	30	70	100
BTP556	Environmental Biotechnology					
	Agricultural/Food biotechnology	5	3	30	70	100
<b>PROJECT WORK</b>						
BTH557	Project Work and Dissertation	4	4	30	70	<b>100</b>
<b>Total</b>			<b>21</b>			<b>600</b>
<b>Grand Total</b>			<b>92</b>			<b>2600</b>



## FIRST SEMESTER SYLLABUS

<b>HARD CORE PAPERS</b>	<b>SOFT CORE PAPERS</b>	<b>OPEN ELECTIVE</b>
BTH401 Biochemistry	BTS404 Molecular Genetics	Nil
BTH402 Microbiology	BTS405 Bio analytical techniques	
BTH403 Cell biology		
BTP406 Biochemistry & Microbiology		
BTP407 Cell biology & Molecular Genetics OR BTP407 Cell biology & Molecular Genetics & Bio analytical techniques		





## BTH401 BIOCHEMISTRY

No of Credits: 4

No. of Hours: 52

### Objectives

- To study about chemical bond, types and its effect on reactivity
- To understand the structure, function and interaction between biological macromolecules in living system

### Unit -I

15Hrs

**Chemical basics of biology:** The atom and chemical bonding, Ionization potential, nature and types of chemical bonding, electron affinity, bond length, bond energy and noncovalent bonds/interactions. Properties of water .

**Carbohydrates:** Classification, structure and Properties of mono, oligo and polysaccharides. Chirality and optical activity, stereoisomerism, cyclic structure of monosaccharide, (pyranoses and furanoses) , structures of glucose. absolute and relative configuration (D & L and R & S nomenclature). Derived sugars- Sugar acids (Aldonic, Aldaric and Saccharic acids), Amino sugars. Disaccharides-structures of Maltose, Lactose, Sucrose, Trehalose, Raffinose. Polysaccharidesstructure and properties of homo and hetero polysaccharides. Storage polysaccharides. (Starch, Glycogen, cellulose, chitin) Glycosaminoglycans and glycoproteins

### Unit – II

12Hrs

**Amino acids and proteins:** Structure, specific rotation, electrochemical properties, Classification and characteristics of amino acids. Nonstandard amino acids, peptide bond and chemical bonds involved in protein structure. Conformational determination of peptide, Ramachandran plot, helix-coil transition, structural organization in proteins. Primary structure determination and synthesis of peptides. Secondary structure- Alpha helix, beta sheet and amorphous structures. Tertiary structure of myoglobin, Quarternary structure-Structural organization of haemoglobin. Proteins – Classification based on source, shape, composition and biological function. Structural organization in silk fibroin



$\alpha$ -keratin, collagen and elastin. Protein folding - Denaturation and renaturation of proteins (Work of Cristian Anfinsen on ribonuclease), folding pathways, the roles of folding accessory proteins and prediction of protein structures (Chou and Fasman scheme). Motifs of proteins: Alpha structure: coiled coil, four helix bundles , & globin motifs with examples , Beta structures : up & down beta barrel, Greek key motif ,jelly roll motifs ,horse shoe motifs ,TIM barrel motifs, Rosmann fold , beta alpha beta motifs

### **Unit – III**

**15Hrs**

**Lipids:** General structure and functions of Fatty acids. Classification – Simple lipids, Compound lipids (phospholipids and glycolipids), Derived lipids (Steroids, Sphingolipids, Terpenes and Carotenoids). Properties of fats and oils – physical properties and chemical properties (Reactions involving COOH group, double bond and OH groups). Biological functions of lipids and eicosanoids (prostaglandins, leucotrienes and thromboxanes).

Vitamins: Biological functions of fat-soluble vitamin: A, D, E & K; Water soluble vitamins, Coenzymes.

### **Unit – IV**

**10Hrs**

#### **hours**

**Nucleic acids:** Introduction, types and structural components (Phosphoric acid, Pentose sugar and Nitrogenous bases). Structure and functions of Nucleosides and Nucleotides. Deoxyribonucleic acid – internucleotide linkages, base composition, evolution of Watson - Crick Model (Chargaff's rule of base pairing in DNA). Denaturation and renaturation of DNA helix (hyperchromism,  $T_m$ , cot). Variants of double helical DNA. DNA's with unusual structures. Interaction of DNA with other molecules (small molecules-ethidium bromide; large molecules-proteins) Ribonucleic acid – differences with DNA. structure and types of RNA (rRNA, tRNA and mRNA).

#### **References:**

1. Nelson, D.L., Cox, M.M. Lehninger. (2004). Principles of Biochemistry 4th edition Pub WH Freeman Co.
2. Elliott, W.H., Elliott, D.C. Biochemistry and Molecular Biology 3rd Indian edition,



Pub. Oxford.

3. Mathews, Van Holde and Ahern, Biochemistry by 3rd edition, Pub Pearson education
4. Stryer, L. Biochemistry 4th Edn. W.H. Freeman and Co. NY.
5. Kuchel, P.W., Ralston Schaums, G.B. Outlines of Biochemistry 2nd edition Pub: Tata.
6. Voet, D., Voet J.G. (2004). Biochemistry 2nd Edn.
7. Devlin, T.M. (1997). Biochemistry with clinical correlations, Wiley-Liss Inc. NY
8. Zubey, G.L. Parson, W.W., Vance, D.E. (1994). Principles of Biochemistry WmC Brown publishers. Oxford.
9. Edwards and Hassall. Biochemistry and Physiology of the cell 2nd Edn. McGraw Hill Co. UK. Ltd.



## BTH402 MICROBIOLOGY

No of Credits: 4

No. of Hours: 52

### Objective:

- Studies about emergence & evolution of micro-organism, streamlining microbial groups into prokaryotes ,eukaryotes & archae with morphological details.
- Tells about nutritional requirement, metabolism & growth kinetics of micro organisms. Microbial community.
- Viral classification with few examples of bacterial, animal & plant viruses with its life cycle.
- Microbial pathogenesis

### Unit I

13 Hrs

Historical perspectives, Microscopy, origin and evolution of microorganisms, principles of classifications, numerical and molecular taxonomy, Comparative morphology, structure and reproduction(Genetic recombination) in archaeobacteria, eubacteria, cyanobacteria,Fungi(Dueteromycetes-phytophthera,Ascomycetes-yeast,Zygomycetes-VAM,Basidiomycetes-Mushroom).

Microbial nutrition, nutritional grouping of microorganism; Growth kinetics, Factors affecting growth and death; methods of isolation, enumeration cultivation and preservation of microorganisms

### Unit II

13 Hrs

Microbial metabolism, Microbial respiration, aerobic and anaerobic respiration(**wrt chemorganotroph & chemolithotroph**), fermentation, Bacterial photosynthesis. General account of symbiosis, mutualism, antagonism, parasitism, commensalism in microorganisms.

### Unit III

13 Hrs



Classification, morphology, ultra structure and life cycle of plant viruses, animal viruses and bacteriophages. DNA viruses: Herpes virus, Adenovirus. RNA viruses: Polio, Influenza, Retroviruses, (HIV); Bacteriophages: Lambda phage, Bacteriophage MU, M13, T4.

#### **Unit IV**

**13 Hrs**

Animal microbe interactions: Tuberculosis, Dermatophytes, Rabies, Mycoplasma, Rickettsiae, Typhoid, Leprosy and Cholera. Antibiotics: Types, mode of action and drug resistance (Cholera, Salmonella and Staphylococcus), Antimicrobial therapy.

Principles of microbial spoilage of food, Methods of food preservation by physical (freezing, canning, pasteurization and irradiation) and chemical (preservatives, lactic antagonism), Methods of Microbial food poisoning (Botulinum, Mycotoxins, Algal toxins(relevance to fresh water & marine algae, Cholera and Salmonellosis).

#### **References:**

1. Brock Biology of microorganisms, Michael T. Madigan , John M. Martinko , Kelly S. Bender 14<sup>th</sup> edition 2012
2. Element of microbiology 5<sup>th</sup> edition– Pelczar J. and Chan ECS. MacGraw Hill New York,1998
3. General Microbiology .Schlegel HG 7<sup>th</sup> ed. Cambridge Univ. Press 1993
4. Microbial biology. Rosenberg E and Cohen IR. .Saunders Coll .Pub.,1983
5. The microbial world. Stanier RY et al 5<sup>th</sup> ed. Prentice Hall New Delhi.1990

#### **Skill components Identified :**

Various bio-safety issues including physical and biological containment, universal containment, personal protective equipment for biological agents

Various isolation precautions including standard and transmission based precautions

In-depth knowledge about various method of Sterilization, and disinfection



Nomenclature, classification and morphology of bacteria as well as other microorganisms

Requirements for growth and nutrition of bacteria along with bacterial metabolism 9.

Microbiology of air, soil, water

Various types of host-parasite relationship and their significance

Various antimicrobial agents and mechanisms drug resistance

Bacterial genetics, bacteriophages and molecular genetics relevant for medical microbiology .

Applications of quality assurance, quality control in microbiology and accreditation of laboratories



## BTH403CELL BIOLOGY

No of Credits: 4

No. of Hours: 52

### Objective:

- To Understand the structure and function of prokaryotic and eukaryotic cells as whole and in terms of their sub-cellular processes.
- To study structural organization of their membranes, transportation of solutes across membranes, cellular development, defence, division both in somatic and gametic cells, cell cycle regulation will be dealt.
- Cell-cell integration, communication, cellular organization into tissue, signalling pathways and its regulation are also the key features which the students will be enlightened.

### Unit I

13 Hrs

Introduction: Prokaryotic and eukaryotic cells; Differences between plant and animal cells.

Membrane structure: Different models of membrane; Structural Organization of Biomembranes - Lipid composition, protein components, membrane carbohydrates; Functions of Biomembranes; Ion channels, Electrical properties of membranes, Nerve impulse transmission; Transport across bio-membranes – active and passive; Endocytosis: Phagocytosis, receptor mediated endocytosis, protein trafficking in endocytosis; Chemical composition of cell walls in plants, bacteria and fungi; Tensile strength, turgor modifications.

### Unit II

13 Hrs

Subcellular Organization: Ultrastructural organization and functions of Golgi complex, endoplasmic reticulum, mitochondria, chloroplast, peroxisomes, lysosomes, ribosomes, nucleus and nucleolus.



### Unit III

13 Hrs

Chromosomes – Structure, organization and types of eukaryotic chromosomes; Types of Chromatin - Heterochromatin, Euchromatin,. Types of chromosomes- Polytene and lamp brush chromosomes; Chromosomal Organization of Genes; Morphology and Functional Elements of Eukaryotic Chromosomes – Telomeres, Centromere, Kinetochore.

Chromosome dynamics during cell division: Mitosis, Meiosis; Centrosome, Microtubule dynamics and motor proteins. Metaphase and Anaphase movements.

Cell cycle and its regulations in yeasts and mammalian cells; extracellular signals, cell cycle check points, cyclins, MPF.

### Unit IV

13 Hrs

Cell signaling: Broad types - endocrine, paracrine, juxtacrine, and autocrine.

Primary and secondary messengers; Hormones and growth factors; cyclic AMP, cyclic GMP, Nitric oxide, Phospholipids and Calcium; G-protein coupled receptors; Enzyme coupled receptors – receptor protein tyrosine kinases, tyrosine kinase associated receptors, receptor protein serine/threonine kinases, non-receptor protein tyrosine kinases, receptor protein tyrosine phosphatases.

Wnt signaling pathway, NF-KB signaling pathway.

Integrating cells into tissues: Cell adhesion molecules; Cell junctions – Anchoring junctions, Tight junctions, Gap junctions and Plasmodesmata; Extracellular matrix.

### References:

1. Molecular Biology of the Cell 5E (2008). Bruce Alberts, Alexander Johnson, Julian Lewis and Martin Raff, Garland Publishing, Inc., New York.
2. Cell: A Molecular Approach, 6th Edition (English) Author: [Robert E. Hausman](#), [Geoffrey M. Cooper](#): Sinauer associates Inc., 2013
3. [Cell and Molecular Biology 8th Edition \(2010\)](#) by [E. D. P. De Robertis](#). CBS Publishers & Distributors





4. [Developmental Biology, 10th Edition \(2013\)](#) by [Scott F Gilbert](#): Ingram International Inc
5. Molecular Cell Biology. – International Edition, (2012) by [Harvey F. Lodish](#) et al., WH Freeman and company, New York.
6. Cell and Molecular Biology: Concepts and Experiments, 7th Edition (2013) Gerald Karp. Wiley &sons, New York.

**Skill component Identified:**

We learn the how and why of biology by exploring the function of the molecular components of cells, and how these cellular components are organized in a complex hierarchy. Learners will have a deep intuition for the functional logic of a cell. Together we will ask how do things work within a cell, why do they work the way they do, and how are we impacted? In laboratory, they will master the most important instrumental techniques required for work in biotechnological and other chemical laboratories.



## BTS404 MOLECULAR GENETICS

No of Credits: 3

No. of Hours: 36

### Objective:

- To Understand genetics of inheritance
- To understand types of mutation & repair mechanism
- To understand genetics diseases through structural & numerical chromosomal abberations

### Unit – I

9 Hrs

**Mendelian Genetics:** Mendel's experiments, Principle of segregation, Symbols and terminology, Monohybrid Crosses (Dominance, Recessiveness, Codominance, Lethal), principle of Independent assortment (Dihybrid ratios, Trihybrid ratios, gene interaction, Epistasis), Genetic versus environmental effects (Penetrance and expressivity), multiple alleles, pleiotropy. Linkage, Crossing- over and Chromosome mapping. Sex determination, dosage compensation and extra-chromosomal inheritance.

**Genetic material:** DNA as genetic material: Experiments of Griffith, Avery MacLeod and McCarthy.

### Unit – II

13Hrs

**Chromosome Structure:** Histones, Nucleosomes, 300-A<sup>0</sup>Filaments, Radial Loops and Polytene Chromosomes.

**Human Cytogenetics:** Variations in chromosome structure – Deficiencies, Duplications, Inversions, Translocations and position effects. Karyotyping human chromosomes – Classification and banding techniques. Chromosome aberrations in humans. Trisomy in humans – Down syndrome, trisomy 13 & 18, Turner syndrome, Klinefelter syndrome, Aneuploidy of X chromosomes and mental deficiency.

**Prenatal diagnosis:** Concept, procedure and applications, (Amniocentesis and Chronic



Villus Sampling)

**Population and evolutionary genetics:** Genetic variation, Random mating and Hardy–Weinberg method, Inbreeding, Out-breeding, Changes in allele frequencies and Evolutionary genetics.

**Unit – III**

**14Hrs**

**Mutation:** Spontaneous versus induced mutation, Mutation: Random rather than directed by the environment (Replica Plating), Phenotypic effects of mutations, Somatic and Germinal Mutations, The molecular basis of mutation, Radiation induced mutation, Chemically induced mutation, DNA Repair mechanisms, Correlation between mutagenicity and carcinogenicity (Ames test).

**Transposable elements:** Discovery, types and their characteristics. Transposable elements in prokaryotes and eukaryotes – IS elements, Composite transposons, Tn3 elements, Ac and Ds elements, P elements, Retrotransposons and their significance.

**References:**

1. Hartl, D. L. and E. W. Jones, 2002 *Essential Genetics*. 3 ed. Jones & Bartlett, Sudbury, Massachusetts. 613 pp.
2. Hartl, D. L. and E. W. Jones, 2004 *Genetics: Analysis of Genes and Genomes*. 6 ed. Jones & Bartlett, Sudbury, MA. 854 pp.
3. Conner, J. K., and D. L. Hartl, 2000 *A Primer of Ecological Genetics*. Sinauer Associates, Sunderland, Massachusetts. 304 pp.
4. pstein RJ (2002) *Human molecular biology*. Cambridge University Press, Cambridge.
5. Gardner A, Howell RT, Davies T (2000) Biomedical sciences explained. *Human genetics*. Arnold, London.
6. Lewin B (2000) *Genes* vII. Oxford University Press, New York.
7. Strachan T, Read AP (2004) *Human molecular genetics* 3. Garland Science, New York.
8. Mobile genetic elements-Shapilo/NY Academic press ,
9. Microbial genetics.Maloy SR. Friefelder /Jones and Bartlett pub., 1994.



## BTS405 BIO ANALYTICAL TECHNIQUES

No of Credits: 3

No. of Hours: 36

### Objectives

- Introduces about principle and application of Biophysical methods

### Unit-I

9 Hrs

**Chromatographic techniques:** General principles, Sample preparation, Selection of chromatographic system, Low pressure column chromatography, HPLC, Adsorption chromatography, Partition chromatography, Ion exchange chromatography, Exclusion chromatography, Affinity chromatography, GLC, TLC, Paper chromatography.

### Unit-II

12 Hrs

**Electrophoretic Techniques:** General principles, Support media, Native gels, SDS-PAGE, Isoelectric Focusing, 2D gel electrophoresis, Agarose gel electrophoresis, Pulse field gel electrophoresis, Capillary electrophoresis.

**Centrifugation Techniques:** Introduction, Basic principles of sedimentation, Types of centrifuges and their uses, Preparative and density gradient separation, Analytical ultracentrifuges and their applications.

**Radioisotope techniques:** Nature of radioactivity, detection and measurement, GM counter, scintillation counting, Safety aspects and applications of radioisotopes in biology.

### Unit-III

15 Hrs

**Spectroscopic techniques:** Introduction, UV and visible light spectroscopy, IR and Raman spectroscopy, Electron Spin Resonance (ESR), NMR, Spectrofluorimetry, Luminometry, Atomic absorption spectrophotometry, X-ray diffraction, Optical Rotatory



Dispersion, Circular Dichroism.

**Mass spectrometric techniques:** Introduction, mass spectrometer and applications. Ionization techniques- Electron impact ionization (EI), Electrospray Ionization, Chemical ionization (CI), Field ionization (FI) and MALDI. Ion desorption and evaporation methods, Analyzers- Magnetic sector, time-of-flight, quadrupole, and ion trap. Detectors- electron multipliers. Tandem mass spectrometry.

**Reference:**

1. Biophysical Chemistry –Principles and techniques-A, Upadhaya – Himalaya pub.
2. Nuclear and Radio chemistry -3<sup>rd</sup> ed. Gerhan Fried Lander John Wiley and sons,
3. Basic concepts of analytical chemistry 2<sup>nd</sup> ed. S.N. Khopkar. New Age Pub.
4. Principles of instrumental analysis .Da Skooge Holt –Saunders, 1985.
5. Text Book of Biochemistry with Clinical Correlations - Thomas M. Devlin (ed) (Wiley-Liss) - 4th Edition.

**Skill component identified :**

- 1) Analytical and Preparative Chromatography
- 2) Basic electrophoretic principles
- 3) Centrifuges used for separation
- 4) UV/ Visible Spectrophotometer
- 5) Chromatography – TLC , Paper Chromatography
- 6) Buffers used in Downstream Lab.



- Colour reactions for mono-, di- and polysaccharides
  - Identification of unknown carbohydrates
  - Estimations of blood glucose, free fatty acids, cholesterol and proteins
  - Estimation of amino acids
  - Estimation of serum proteins
  - Estimation of blood urea
  - Determination of urine creatinine
  - Tests for nonprotein nitrogen (NPN) substances
  - Determination of plant phenolics and ascorbic acid
  - Chromatography (TLC and Column)
  - Colorimetry
  - Flame photometry
  - Electrophoresis
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- Microscopic observations of microorganisms
  - Microbial staining techniques (simple and differential staining, cell wall, endospores, intracellular lipids, acid-fast, flagella, viability)
  - Microbial motility tests
  - Sterilization techniques
  - Microbial culture media and their preparation
  - Qualitative and quantitative assessment of microflora in soil, water, air, and food
  - Milk microbiology
  - Studies on bacteria, fungi and actinomycetes
  - Studies on symbiotic association of microorganisms

\* Practical exercises to be conducted with back ground of respective theory papers.(BTH401,BTH402,BTH403,BTS404)



## SECOND SEMESTER SYLLABUS

HARD CORE PAPERS	SOFT CORE PAPERS	OPEN ELECTIVE
BTH451 Molecular biology	BTS453 Metabolism	BTE458 Applications of Biotechnology
BTH452 Genetic Engineering	BTS454 Enzymology	BTE459 Recombinant DNA Technology
BTP456 Molecular biology & Genetic Engineering	BTS455 Biostatistics & Bioinformatics	
	BTP457 Metabolism & Ezymology OR BTP457 Metabolism & Biostatistics & Bioinformatics	



## BTH451 MOLECULAR BIOLOGY

**No of Credits: 4**

**No. of Hours: 52**

### Objectives

- Study of transfer of sequential information through central dogma of life
- Introduce about replication of Nucleic acid, Transformation and translation
- Explains DNA damage and Repair mechanism
- Molecular and cellular biology of fertilization

### Unit – I

**15 Hrs**

**DNA Replication:** Experimental evidence for semi conservative DNA replication, Replication Forks, Role of DNA Gyrase, Semi discontinuous Replication, RNA primers. Enzymes of replication – DNA polymerase I, DNA polymerase III, Helicases, Binding proteins, Nuclease and DNA Ligases. Prokaryotic replication mechanisms – Bacteriophage M13, Bacteriophage ØX174, *E. Coli*(DnaA protein) and Fidelity of replication. Eukaryotic DNA replication – Cell cycle, Eukaryotic DNA polymerases, Reverse transcriptase, Telomeres and Telomerases.

**Repair of DNA:** Direct reversal of damage, Nucleotide Excision repair, Recombination repair, The SOS response and identification of carcinogens.

### Unit II

**15 Hrs**

**Transcription:** Role of RNA in protein synthesis – Enzyme induction (Lactose Operon), Messenger RNA. RNA Polymerase – Enzyme structure, Template binding, Chain initiation, Chain Elongation, Chain termination and Eukaryotic RNA Polymerases.

**Control of Transcription in Prokaryotes:** Promoters, *lac* Repressor, Catabolite Repression (example of gene activation), Sequence-Specific Protein – DNA interactions,





*araBAD* Operon (Positive & negative control by same protein), *trp* Operon (Attenuation) and Regulation of Ribosomal RNA synthesis (Stringent response).

### Unit – III

12 Hrs

**Genetic Code:** Chemical mutagenesis, Codons Assignment (Deciphering the genetic code) and characteristics of genetic code.

**Translation:** Transfer RNA and its Aminoacylation – Primary and Secondary structures of tRNA, Tertiary structure of tRNA, Aminoacyl-tRNA synthetases, Codon – Anticodon interactions (Wobble hypothesis) and nonsense suppression. Ribosomes – Structure, Polypeptide synthesis (An overview), Chain initiation, Chain Elongation, Chain Termination, Translational Accuracy and Protein synthesis inhibitors (Antibiotics).

### Unit – IV

10 Hrs

Control of Eukaryotic Translation: Translational control by Heme, Interferon, mRNA masking and Antisense RNA.

Posttranscriptional Processing: Messenger RNA Processing, Ribosomal RNA Processing and Transfer RNA Processing.

Posttranslational Modification: Proteolytic cleavage and Covalent modifications

Protein Degradation: Degradation specificity and degradation mechanisms

### References:

1. Alberts, B., Bray D., Lewis J., Raff, M., Roberts K., Watson, J.D., (eds) 2002. Molecular biology of the Cell, 4<sup>th</sup> edn., Garland Publishing, Inc., New York.
2. Cooper, Geoffrey M. The cell – A Molecular Approach 2<sup>nd</sup> ed. Sunderland (MA) : Sinauer Associates, Inc; 2000
3. De Robertis, E.D.P and De Robertis, E.M.F. 1995 Cell and Molecular Biology .8<sup>th</sup> edn, B.I. Waverly Pvt Ltd., New Delhi.
4. Griffiths, Anthony J.F.; Gelbart, William M.; Miller, Jeffrey H., Lewontin, Richard C New York : W.H, Freeman & Co., 1999



5. Harvey Lodish, Arnold Berk, S. Lawrence Zipursky, Paul Matsudaira & David Baltimore Molecular Cell Biology, 4<sup>th</sup> edn. 2000, W.H. Freeman & Company, New York.
6. Karp G. 1999. Cell and Molecular Biology-Concepts, and experiments. 2<sup>nd</sup> ed. John Harris, D. (ed) Wiley & Sons, New York.
7. Kleinsmith, I.J. & Kish, V.M. 1995 Principles of Cell and Molecular Biology. 2<sup>nd</sup> edn, McLaughlin, S., Trost, K., Mac Elree, E. (eds), Harper Collins Publishers, New York.
8. Lewin, B., 2000, Genes VII. Oxford University Press



## BTH452 GENETIC ENGINEERING

**No of Credits: 4**

**No. of Hours: 52**

### **Objective:**

- Introduces basics of genetic engineering with its tools & techniques
- Explains invitro & invivo gene cloning, use of vectors, construction of compatible ends, creating rDNA, and its transfer into host, construction of genomic & cDNA libraries .
- Methods of selection of recombinants.
- Applications of genetic engineering

### **Unit I**

**13 Hrs**

General introduction to concepts of genetic engineering. Host controlled restriction and modification, restriction endonucleases, target sites sticky, cohesive ends and blunt ended fragments. Role of DNA ligase, linkers, adaptors, homopolymer tailing.

Other methods of joining DNA molecules: TA cloning of PCR products, Construction of genomic libraries, construction of cDNA library, methods of cDNA synthesis;

PCR: Optimization of PCR reaction, analysis of products, Nested PCR, Application of PCR in cloning, agriculture and medicine. RT-PCR – technique and applications.

### **Unit II**

**13 Hrs**

Vectors: Vectors in Gene Cloning, Basic properties of plasmids, desirable properties of plasmid cloning vehicles, natural plasmid. Artificial vectors: PBR 322, Improved vehicles derived from PBR 322, PUC. Vectors for transforming bacteria and yeast, animals and plants Special vectors: Shuttle vectors, expression vectors, Construction of Artificial chromosomes vectors BACs, YACs and MACs. Cosmids, phagemids, Viral vectors Techniques of introducing genes in Prokaryotes and eukaryotes: transformation, calcium



phosphate method, DEAE – Dextran method, Liposome mediated transfer, microinjection, electroporation and gene gun.

### **Unit III**

**13 Hrs**

Identifying the right clones; Direct screening: Insertional inactivation of marker gene, visual screening, plaque phenotype .indirect screening: Immunological techniques, Hybrid arrest translation, Hybrid select translation. Screening using probes: construction of gene probes, hybridization and labeling. Nucleic acid hybridization – Southern blotting, colony hybridization, dot blot; Chromosome walking and chromosome jumping.

DNA sequencing: Maxim & Gilbert's method, Sanger & Coulson's method, Messing's shot gun method, automated sequencers. Analysis of genetic variation: Single nucleotide polymorphism, conserved and variable domains, RFLP, AFLP, RAPD. Genome sequencing: overview, strategies (e.g. Human genome project.)

### **Unit IV**

**13 Hrs**

Mapping of DNA: Restriction mapping, DNase foot printing, Use of transposons in gene mapping.

Analysis of gene expression: Analysis of transcription by Northern blot, RNase protection assay, Primer extension assay, *in situ* hybridization. Comparing transcriptomes: Differential screening, subtractive hybridization, array based methods; implication of genetic engineering.

Translational analysis: Screening expression libraries with antibodies –Western Blot, two dimensional electrophoresis, Proteomics.

Manipulating gene expression: Transcriptional fusions, translational fusions, *In vitro* mutagenesis, Oligonucleotide directed mutagenesis, deletions, Insertional mutagenesis, direct single base mutagenesis

### **References:**

- 1) From genes to clones –Winnaker ,panima educational book agency



- 2) Gene IX- Lewin ,Oxford UniversityPress,2007
- 3) Principles of gene manipulation- Old and primrose –Blackwell scientific pub.,6th Ed,2006
- 4) Recombinant DNA technology –Watson JD et al Scientific American books, 3<sup>rd</sup> Ed1992

**Skill component Identified :**

Techniques for isolation, handling, and processing of nucleic acids,

Principles of nucleic acid hybridisation,

Gel electrophoresis techniques

Enzymes used in gene manipulation, features of plasmid vectors and DNA cloning , Transformation assays



## BTS453 METABOLISM

**No of Credits: 3**

**No. of Hours: 39**

### **Objective:**

- To learn how organisms acquire and use the energy and material resources needed to complete their life cycle, highlighting relationships between structure and function, and coordination of development, resource acquisition and environmental responses within and across cells, tissues and organs
- To learn how biological systems use free energy based on empirical data that all organisms require constant energy input to maintain organization, to grow and to reproduce and how changes in free energy availability affect organisms, populations and ecosystems
- To understand what mechanisms and structural features allow organisms to capture, store and use free energy will be dealt in details under the heading of nucleic acid, protein, lipid and carbohydrate metabolism.

### **Unit I**

**13 Hrs**

Thermodynamic principles, free energy, enthalpy and entropy, chemical equilibrium, reaction kinetics, redox processes. ATP as an energy currency in the cell and other high energy compounds. Standard free energy, coupled reaction.

Carbohydrate metabolism: Glycolysis, inter conversion of various monosaccharides citric acid cycle, Amphibolic pathway of citric acid cycle, Anaplerotic reaction, Gluconeogenesis, Glycogenesis, Pentose phosphate pathway, HMP shunt.. Biological oxidation: Electron Transport Chain, Chemiosmotic hypothesis, ATP synthesis, Oxidative phosphorylation, Substrate level phosphorylation, Uncouplers and Inhibitors of respiration.

### **Unit II**

**13 hrs**

Amino acid metabolism: Deamination, transamination, transdeamination, decarboxylation,



Urea cycle, Ketogenic and Glucogenic amino acids. Metabolism of aromatic amino acids, histidine, cystein and serine.

Nucleic acid metabolism: Biosynthesis, *de novo* and salvage pathways, catabolism of purine and pyrimidine

### Unit III

13 hrs

Oxidation of fatty acids,  $\alpha$ ,  $\beta$  and  $\omega$  types. Energetics of beta oxidization. Biosynthesis of fatty acids, Cholesterol biosynthesis, Ketone body formation, Interconversion of phospholipids.

Photosynthesis: Photosystems, Light harvesting complexes, cyclic and non cyclic electron transfer, photophosphorylation, Calvin cycle, C3 and C4 plants, CAM

### References:

1. Biochemistry –Lubert Stryer , 3<sup>rd</sup> ed. , Freeman & co ,New York, 1988
2. Bio chemistry –Zubay 2<sup>nd</sup> ed. Mac millan pub., 1988
3. Harpers review of Biochemistry. Martin *et, al.*, 25<sup>th</sup> edition. Large medical pub. 2000.
4. Principles of instrumental analysis .Da Skooge Holt –Saunders, 1985.
5. Principle of Biochemistry –A. Lehninger, David L. Nelson and M.M Cox CBS pub. 1993
6. Text book of biochemistry with clinical correlation. TM Devlin John Wily and sons, 5<sup>th</sup> Edition., 2002.

### Skill component Identified:

Students will extend their knowledge of biochemistry fundamentals and will learn about important metabolic processes taking place in organisms. In this course, they will acquire a detailed knowledge about photosynthesis, metabolism of Saccharides, metabolism of nitrogen compounds and regulation. In laboratory, they will master the most important instrumental techniques required for work in biotechnological and other chemical laboratories.



## BTS454 ENZYMOLOGY

No of Credits: 3

No. of Hours: 36

### Objectives:

- To make the students understand the basic structures & functions of enzymes & their role in physiology
- To make the students appreciate the diversity of enzymes and their multiple roles in achieving system homeostasis.
- To inculcate the knowledge & skills used in present day biotechnology industries, which find enzymes as one of the key therapeutics.

### Unit – I

13 Hrs

**Enzyme catalysis:** Nomenclature and classification, Isoenzymes, Biological role of enzymes, chemical nature of enzymes and characteristics of enzymes. Isolation of enzymes, enzyme assays, extraction of soluble and membrane bound enzymes. Purification of enzymes, Criteria of purity and determination of molecular weights of enzymes. Specificity of enzyme action – types of specificity, active site, Fischer ‘lock-and-key’ hypothesis and Koshland's ‘induced-fit’ hypothesis. Catalytic mechanisms – Acid-base catalysis, Covalent catalysis, Metal ion catalysis, electrostatic catalysis, and catalysis by preferential transition state binding and catalysis through proximity and orientation effects. Factors affecting enzyme catalyzed reaction

### Unit – II

13 Hrs

**Enzyme Kinetics:** Rates of reactions, transition state theory, Michaelis-Menten Equation, Significance of  $V_{max}$  and  $K_m$ , Lineweaver-Burk plot, Eadie – Hofstee and Hanes plot, Eisenthal and Cornish-Bowden plot.

**Enzyme inhibition:** Irreversible and Reversible inhibition – Competitive, Uncompetitive, non-competitive, mixed, partial, substrate and allosteric inhibition, determination of  $K_i$





(Dixon plot).

**Bisubstrate Reactions:** Terminology, Sequential reactions, Ping pong reactions, Rate equations, Differentiating bisubstrate mechanisms and Isotope exchange.

### Unit – III

10 Hrs

**Allosterism:** Cooperativity-positive and negative cooperativity, Sigmoidal kinetics, MWC and KNF models, Aspartate carbamoyl transferase (ACTase).

**Molecular mechanism of enzyme action:** Mechanism of chymotrypsin, ribonuclease, and lysozyme.

**Application of enzymes:** In medicine – Reagents in clinical chemistry, assay in plasma enzymes, Enzymes and inborn errors of metabolism. In industry – Food, drink and other industries. Immobilized enzymes – Preparation, properties and applications.

#### Reference:

1. Enzymology And Enzyme Technology 1st Edition (2011) By S.M. Bhatt. S.Chand Publishing
2. Enzymes: Biochemistry, Biotechnology, Clinical Chemistry By Trevor Palmer Horwood Publishing Ltd; 5th Revised Edition (2001)
3. Enzyme Technologies: Metagenomics, Evolution, Biocatalysis And Biosynthesis (Chemical Biology Of Enzymes For Biotechnology And Pharmaceutical Applications) By [Wu-KuangYeh](#) , [Hsiu-Chiung Yang](#), [James R. Mccarthy](#) (2010). Publisher: Wiley-Blackwell
4. Enzyme Technologies: Pluripotent Players In Discovering Therapeutic Agent (Chemical Biology Of Enzymes For Biotechnology And Pharmaceutical Applications) By [Wu-KuangYeh](#) , [Hsiu-Chiung Yang](#), [James R. Mccarthy](#) (2014). Publisher: Wiley-Blackwell
5. Enzyme Technology (1990) By [Martin F. Chaplin](#), [Christopher Bucke](#). Cambridge University Press
6. Industrial Enzymes: Structure, Function And Applications (2007)By [Julio](#)



[Polaina](#), [Andrew P. Maccabe](#), Springer Publishing Group

7. Immobilization Of Enzymes And Cells (Methods In Biotechnology), 2006. By [José M. Guisán](#). Humana Press



## BTS455 BIOSTATISTICS & BIOINFORMATICS

No of Credits: 3

No. of Hours: 36

### Objectives

- Introduce the concept of statistics and its tools in biological system
- To provide the basic knowledge about computers and information storage devices
- Application of computer software in handling biostatistical problems
- To understand the role and application of bioinformatics

### Unit-I

10Hrs

Introduction and definition of biostatistics, concept of variables in biological systems, collection, classification, tabulation, graphical and diagrammatic representation of numerical data, Measure of central tendency: Mean median and mode, and their relationship, Measure of dispersion: quantitative deviations, mean deviation, standard deviation, coefficient of variations. Correlation and regression, linear and quadratic regressions, Concept of Standard errors. Hypothesis testing (null & alternative hypothesis)

### Unit-II

10Hrs

Probability, concept of random experiment, various definition of probability, addition theorem of probability, random variables(discrete and continues), Probability distributions (viz. Binomial, Poisson and Normal) and their applications, Simple random sampling without replacement. Student 't-', 'F' and 'Chi' square distribution (derivations not required) their properties and use. ANOVA.

### Unit III

16Hrs

Bioinformatics- an overview, Definition and History, Applications of Bioinformatics. **Genomics**-Introduction to Genomics, Nucleotide Sequence Analysis, Pair wise Alignment, global and local alignment, and significance of alignment, Goals and types of



alignment, Tools of sequence alignment, Homology sequence search, Parameters of Blast, BlastN, BlastP, Interpreting Blast Results.

Sequence formats- Homology and similarity. Introduction to Data mining, NCBI, EBI, DDBJ, Database search software: ENTREZ, SRS, Expasy.

**Proteomics-** Introduction to Proteomics. Protein Sequence Databases, UNIPROT, Structure Database, PDB Sequence Analysis, definition of sequence analysis, Multiple sequence analysis, Parameters of CLUSTAL-W, interpretation of Clustal W Output, DNA Sequence Alignment, Protein Sequence alignment. RASMOL Display Styles Wire Frame, Ball And Stick, Space Fill, Ribbons, Cartoons. EMBOSS Introduction to emboss Software package or any other latest commercial software.

### References:

1. Bioinformatics(2002) Bishop Martin
2. Molecular databases for protein and sequence and structure studies: Sillince A. and Sillince M.
3. Sequence Analysis primers : Gribskov, M. and Devereux, J.
4. Bioinformatics: Sequence and Genome Analysis By David W. Mount, *University of Arizona, Tucson*
5. Discovering Genomics, Proteomics, & Bioinformatics, Second Edition By A. Malcolm Campbell, *Davidson College*; Laurie J. Heyer, *Davidson College*; With a Foreword by Francis S. Collins
6. Biostatistics:P.N.Arora ,P.K.Malha
7. Introductory statistics for Biology: *Mahajan , S. K.*
8. Statistical Methods :*Mishra and Mishra*

### References:



1. Biotechnology, Biosafety and Biodiversity .Sivamiah Shantaram,Jane F Montgomery. Oxford and IBH pub., New Delhi
2. Biotechnology and Law- IPR vol. 1 & 2 by Iver P. Cooper, Clark Boardman Callaghan,1993.
3. Principles of Management – P.C.Tripathi, P.N.Reddy – Tata McGraw Hill,
4. Dynamics of Entrepreneurial Development & Management– Vasant Desai – Himalaya Publishing House
5. Entrepreneurship Development –Poornima.M.Charantimath – Small Business Enterprises Pearson Education – 2006 (2 & 4).
6. Management Fundamentals – Concepts, Application, Skill Development – RobersLusier – Thomson
7. Entrepreneurship Development – S.S.Khanka – S.Chand&Co.
8. Management – Stephen Robbins – Pearson Education/PHI –17th Edition, 2003



## BTE458 APPLICATIONS OF BIOTECHNOLOGY

No of Credits: 3

No. of Hours: 36

### Objective:

- To explore branches & benefits of new avenues in Biotechnology
- To Introduction to cell culture basics of asepsis, role of media & its components, various equipments used in cell culture.
- To understand the impact of biotechnology on the agricultural industry, the limitations of conventional cross-breeding techniques as a means of developing new plant products and why plants are especially suitable for genetic engineering. Outline several ways in which biotechnology might reduce hunger and malnutrition around the world
- To create awareness and responsibilities about the environment and society

### Unit I

13 Hrs

Biotechnology: Introduction, branches, scope; Biotechnology

Plant tissue culture: Totipotency; Tissue culture media; Plant hormones, types and application, artificial seeds.

Approaches for the production of Genetically Modified Products: Transgenic plants — Bt Cotton, Bt Brinjal, Golden Rice, Flavor Savor Tomato, Herbicide tolerant transgenic plants, stress resistant plants.

ELISA and its application; Biosensors

### Unit II

13 Hrs

Animal tissue culture: laboratory design, aseptic conditions, media, Role of carbon dioxide. Role of serum and supplements merits of Serum & serum free media and their applications, Equipments for animal cell culture technology.

Basic techniques: Dis-aggregation of tissue and primary culture; maintenance of cell culture; Measurement of viability and cytotoxicity. Cell separation techniques, scaling-up of animal cell culture –Bioreactors used in animal cell culture.



Stem cells and their applications, Test tube baby, Cryo-preservation Techniques.

### Unit III

10Hrs

Bio Plastics; Microbial mining; Microbial influenced corrosion and remedies;  
Treatment of solid wastes - composting and vermi composting.

Treatment of liquid wastes - aerobic and anaerobic treatments sewage and effluent treatments.

Biomolecules from the sea; Scope of Marine biotechnology; Environmental issues of aquaculture

### References:

1. Colin Ratledge (Editor), Bjorn Kristiansen (Editor) Basic Biotechnology - Second Edition, Paperback: 584 pages Publisher: Cambridge University Press; 2nd edition (May 15, 2001) ISBN: 0521779170
2. Gary Walsh (Author) Biopharmaceuticals: Biochemistry and Biotechnology Paperback: 551 pages Publisher: John Wiley & Sons; 2nd edition (September 2003) ISBN: 0470843276
3. S. B. Primrose, Molecular Biotechnology - Second Edition
4. 208 pages , Publisher: Blackwell Science Inc; 2nd edition, SIN: 0632030534
5. Molecular Biotechnology: Principles and Applications of Recombinant DNA
6. Bernard R. Glick, Jack J. Pasternak, Molecular Biotechnology: Principles and Applications of Recombinant DNA
7. 708 pages , Publisher: Amer Society for Microbiology; 2nd edition (March 2003) ISBN: 1555811361
8. R.C Dubey, 2010. Text book of biotechnology by
9. U.Sathyannarayana, 2008. Text book of Biotechnology by
10. B.D. Singh, 2007. Biotechnology
11. Brock TB and Madigon , 1988. Biology of microorganisms, Prentice Hall
12. Pelczar J. and Chan ECS. Mac 1988. Elements of microbiology, Mac-Graw Hill New York.
13. Schlegel HG, 1988. General Microbiology . (6<sup>th</sup>ed), Cambridge Univ. Press



## BTE459 RECOMBINANT DNA TECHNOLOGY

No of Credits: 3

No. of Hours: 36

### Objective:

- To discuss the gene cloning methods and the tools and techniques involved in gene cloning and genome analysis and genomics.
- To explain the heterologous expression of cloned genes in different hosts,
- production of recombinant proteins and PCR techniques.

### Unit I

12Hrs

Gene cloning Introduction and Scope of rDNA technology, General concept, restriction endonucleases, enzymatic tools for gene cloning, linkers and adaptors. Vectors Used in Gene cloning. Plasmids (pBR 322, PUC Vectors, Yeast plasmid vectors. Ti plasmid, binary vector, Cointegrate vector. Cosmids, phagemids. Shuttle vectors. Expression vectors.

### Unit II

12Hrs

Gene transfer methods, Identification and analysis of cloned DNA. Approaches for identification of genes (colony and plaque hybridization, Immunological detection, Southern blot analysis) Radioactive labelling, Non-radioactive labelling.

### Unit III

12Hrs

Methods in rDNA technology- Antisense & ribozyme technology Introduction and scope, Molecular mechanism of antisense molecules, ; PCR in molecular diagnostics; Viral and bacterial detection.;RFLP,RAPD,AFLP,DNA finger printing, Gene knock out & Gene therapy.

### References:

- 1) From genes to clones –Winnaker ,panima educational book agency





- 2) Gene IX- Lewin ,Oxford UniversityPress,2007
- 3) Principles of gene manipulation- Old and primrose –Blackwell scientific pub.,6 th Ed,2006
- 4) Recombinant DNA technology –Watson JD et al Scientific American books, 3<sup>rd</sup> Ed1992

- Autoradiography to study the structure of molecules
- Induction of tumors and its prevention
- Structure of sperms and eggs



- Spermatogenesis (e.g. grass hoppers)
  - Chick and Drosophila developmental stages
  - Historical identification of germ layers of developing embryos
  - Induced breeding in fishes
- 
- Isolation of DNA and RNA from bacteria, plants and yeasts
  - Southern and Northern blotting techniques
  - Western Blotting
  - Studies on DNA replication
  - Studies on vectors
  - Ti plasmid
  - Probes
  - Chromosome mapping
  - Sequencing
  - PCR techniques
  - Construction of DNA libraries
  - Genomics and Proteomics
  - Study of mutagenesis
  - Extraction, isolation and purification of soluble and membrane bound enzymes
  - Enzyme assays
  - Study of enzyme kinetics (effect of substrate concentration, pH, temperature and metal ions)
  - Determination of  $K_m$  and  $V_{max}$
  - Mechanism of enzyme inhibition
  - Immobilization of enzymes and their applications
- 
- Proximate analysis of foods and feeds (moisture, nitrogen, crude fiber, crude lipids and ash)
  - Analysis of antinutritional factors-(e.g., phenolics, tannins, DOPA, trypsin inhibitors)
  - Calculation of calorific value
  - Mineral analysis of foods and feeds
  - Vitamin assay ( water soluble and fat soluble )
  - Production and quantification of organic acids (e.g., citric acid, lactic acid, butyric acid )
  - Catabolism of purine and pyrimidine.
  - Fatty acid oxidation
  - Experiments on photosynthesis (C3 and C4 plants)
  - Estimation of secondary metabolites ( e.g., alkaloids, antibiotics)

\*Practical exercises to be conducted with background of respective theory papers (BTH 451 ,BTH 452 ,BTS453, BTS454)



### THIRD SEMESTER SYLLABUS

HARD CORE PAPERS	SOFT CORE PAPERS	OPEN ELECTIVE
BTH501 Plant Biotechnology	BTS503 Bioprocess Technology	BTE508 Industrial Biotechnology
BTH502 Animal Biotechnology	BTS504 Microbial Technology	BTE509 Bioentrepreneurship
BTP506 Plant Biotechnology & Animal Biotechnology	BTS505 Nano Biotechnology	
	BTP507 Bioprocess & Microbial Technology OR BTP507 Bioprocess Technology & Nano Biotechnology	



## BTH501 PLANT BIOTECHNOLOGY

No of Credits: 4

No. of Hours: 52

### Objective:

- To understand the impact of biotechnology on the agricultural industry, the limitations of conventional cross-breeding techniques as a means of developing new plant products and why plants are especially suitable for genetic engineering. Outline several ways in which biotechnology might reduce hunger and malnutrition around the world
- To learn different methods of in-vitro culture and maintenance of explants, role of gene banks, artificial seeds, cryopreservation, and tissue culture as a novel means of gene storage
- To list and describe several methods used in plant transgenics emphasizing the use of *Agrobacterium* and the Ti plasmid as a gene vector.
- Listing transgenic crops improved by genetic engineering. Outline the environmental impacts, both pros and cons, of crops enhanced by biotechnology. Analyze the health concerns raised by opponents of plant biotechnology.

### Unit I

13 Hrs

Plant genome structure, gene families in plants, organization of chloroplast genome, mitochondrial genome and their interaction with nuclear genome, RNA editing in plant mitochondria. Mitochondrial DNA and Cytoplasmic male sterility. Plant breeding mechanism: types and applications

Plant Tissue Culture – Historical perspective; Lab set up, media components & sterilization, Totipotency, Plant hormones

### Unit II

13 Hrs

Micropropagation- Callus culture, Organogenesis, Meristem, embryo culture, Somatic



embryogenesis, their regulation and application; Artificial seed production; Somaclonal variation; Haploids: Androgenesis, Gynogenesis, Parthenogenesis and its applications in genetics and plant breeding; Germplasm conservation and cryopreservation. Physical, genetic, chemical and genotypic factors. Problems in plant tissue culture (Recalcitrance, Contamination, Phenolic Browning and Seasonal Variation);

### **Unit III**

**13 Hrs**

Genetic Transformation – Cointegrate and binary vectors and their utility; Ti & Ri plasmid based vectors, Screenable and selectable markers; *Agrobacterium*-mediated gene delivery; Direct gene transfer - PEG-mediated; Transgenic stability, gene silencing and removal of marker genes. Characterization of transgenics; Marker-free methodologies; Plant secondary metabolites-Hairy root culture

Process of Nitrogen fixation in legumes by *Rhizobium* , *Cyanobacteria* and *actinomycetes*, nif and nod genes.

Protoplast Culture and Somatic Hybridization – Protoplast isolation, culture and usage; Somatic hybridization- methods and applications; Cybrids and somatic cell genetics

### **Unit IV**

**13 Hrs**

Transgenic plants — enhancing resistance to pests, nutritional value, modification of ornamental plants, bioengineered food, vegetable vaccines, plantibodies and biopharming.

Generation of agriculturally important plants: Expressing viral coat proteins and bacterial toxins in plants; Herbicide tolerant transgenic plants, single gene traits; new colours and patterns in flowers; Production of human proteins in plants. Development of transgenic plants for virus, bacteria, fungi, insect resistance, stress resistant plants.

### **References:**

1. Biotechnology in Agriculture and forestry Bajaj YPS series. Springer Verlag pub, 1986.
2. Biotechnology of higher plants-Russell ,1988.
3. Plant Cell, Tissue & Organ Culture: Fundamental Methods by O. L. Gamborg (Editor) and G. C. Phillips (Editor) (2004)J.Narosa pub.



4. Plant Biotechnology-Mantell and Smith-Cambridge univ press,1986.
5. Introduction To Plant Biotechnology/3rd Edn by Chawla H. S. (2009)
6. Plant Tissue Culture by Kalyan Kumar De (2008), Kalyani pub., Kolkata
7. Plant Tissue Culture: Theory And Practice, 5th Revised Edition (2005)  
Author: [Bhojwani S. S.](#), Elsevier Science
8. Molecular Biotechnology: Principles and Applications of Recombinant DNA Hardcover – 4<sup>th</sup> Ed. (2010) by [Bernard J. Glick](#) , [Jack J. Pasternak](#), [Cheryl L. Patten](#). American Society for Microbiology

### **Skill component Identified**

Students are introduced to the principles, practices and application of plant biotechnology, tissue culture, plant genomics, genetic transformation and molecular breeding of plants. Applied aspects of plant biotechnology in the sectors such as medicine, agriculture, industry will be explored. In laboratory, they will master the most important techniques required for work in many of the related companies.



## BTH502 ANIMAL BIOTECHNOLOGY

No of Credits: 4

No. of Hours: 52

### Objective:

- Introduction to cell culture basics of asepsis, role of media & its components, various equipments used in cell culture.
- Initiation of cell culture, tissue degradation methods, cell separation techniques, viability assessments, mass culture of cells
- Applications of cell cultures in IVF, creating transgenic fishes, synthesis of commercial important molecules from cells .Animals used as bioreactors

### Unit I

13 Hrs

Animal tissue culture; History, laboratory design, aseptic conditions, methodology and media; Balanced salt solution and simple growth medium. Brief discussion on the chemical, physical and metabolic functions of different constituents of culture medium. Role of carbon dioxide. Role of serum and supplements. Serum & protein free defined media and their applications; Equipments and materials for animal cell culture technology.

Basic techniques: Mammalian cell culture *in vitro*; disaggregation of tissue and primary culture; maintenance of cell culture; Cell lines – Characteristics and routine maintenance. Measurement of viability and cytotoxicity. Cell separation techniques, Bioreactors used in animal cell culture

### Unit II

13 Hrs

Biology and characterization of the cultured cells: measuring parameters of growth. Cell synchronization, Somatic cell fusion, Cell cloning. Organ and histotypic cultures. Application of animal cell culture: Stem cell cultures, embryonic stem cells and their applications. Cell culture based vaccines.

Culturing of specialized cells: Epithelial, mesenchymal, neuro ectodermal, hematopoietic gonad



and tumor cells, Lymphocyte preparation, culture of amniocytes, fish cells.

### Unit III

13 Hrs

*In vitro* fertilization (IVF) & Embryo Transfer (ET); Sex determination or sex specific markers, sexing of sperm and embryos and Assisted Reproductive Technology (ART). *In vitro* gamete maturation, Intracytoplasmic sperm injection, Cryopreservation of gametes and embryo. Animal cloning - reproductive cloning , therapeutic cloning, xenotransplantation

### Unit IV

13 Hrs

Transgenic approach for improvements of animals with specific examples - Animals as bioreactors. Applications of biotechnology in Sericulture. Production of Transgenic fishes- Transfer of Antifreeze Protein gene, jelly fish Aquarin (GF) gene, and Stress protein to fishes. General steps to make and analyse Transgenic fish, Genetically Improved Farmed Tilapia (GIFT).

Genetic engineering for production of regulatory proteins: blood products, and hormones., Gene therapy, Types of gene therapy, somatic versus germ line gene therapy , mechanism of gene therapy, Immunotherapy ,gene knockout

### References:

1. Animal Transgenesis and Cloning by Louis –MarleHoudebine John Wiley & Sons, 2003.
2. Animal cell culture and Technology by Michel Butler BIOS Scientific Publishers; 2<sup>nd</sup> edition, 2004.
3. Animal Cloning: The science of Nuclear transfer (The New Biology) by Joseph Panno Facts on File, 2004.
4. At the Bench: A laboratory Navigator by Kathy Barker.
5. Basic Cell Culture: A Practical Approach(Practical Approach Series) by J.M Davis ,2<sup>nd</sup> edition 2002 oxford university press, oxford.
6. Culture of animal Cells: A Manual of Basic Technique 4<sup>th</sup> edition by R. Ian Freshney Wiley -Liss,2000)
7. Gene VII, Oxford University Press , NewYork,B.Lewin,2000.





8. Gene Biotechnology, Second Edition by William Wu, Michael J. Welsh ,Peter B. Kaufman ,Helen H. Zhang CRC Press; 2<sup>nd</sup> Edition,2003.
9. Molecular Biotechnology , ASM Press , Washington , B.R Glick & J.J Pasternak, 1994.
10. Principles of Gene Manipulation by Blackwell Publishers; 6<sup>th</sup> edition, 2002, Sandy B. Primrose , Richard M. Twyman , Robert W.Old.
11. Principles of Cloning by Jose B . Cibelli, Robert P, Lanza, Keith Campbell Michael D. West Academic Press,2002.
12. Recombinant DNA Technology, 2<sup>nd</sup> Edition, Scientific American Books, NewYork,J.D Watson , M .Gilman , J . Witkowski&M.Zoller, 1992.
13. Studies in Biotechnology series 7\_ Fish Biotechnology ,Dr. MM .Ranga& Dr. Q.J ShamniAgrobios (India), Agro House.

**Skill component identified:**

General safety measures

Personal protection

Cell isolation techniques by physical method

Trypsinization

Viability check

Toxicity assessment & Determination of LD50



## BTS503 BIOPROCESS TECHNOLOGY

No of Credits: 3

No. of Hours: 36

### Objectives

1. To demonstrate, reinforce and extend the principles of bioprocess technology
2. To provide knowledge in microbial kinetics
3. To familiarize about types of fermentation process and optimization covering all areas of industrial microbiology

### Unit I

10 Hrs

Basic principles in bioprocess, advantages of bioprocess over chemical process. Isolation and improvement of industrially important strains. Design of fermentation media, inoculum development, Sterilization- sterilization of medium, air and fermentors. Thermal death kinetics.

### Unit II

13 hrs

Design of fermentors: criteria for ideal fermentor, aeration, agitation, valves, baffles, heat exchanges. Types of Fermentors- Waidhof-type fermentor, tower fermentor, cylindroconical vessels, air-lift fermentor, deep-jet fermentor, the cyclone column, the packed tower, rotating disc fermentor. Animal cell culture fermentor – stirred fermentor, micro carrier encapsulation, hollow fiber chambers, packed glass bead reactors. Cell immobilization techniques. Types of fermentation processes: submerged fermentation, surface or solid substrate fermentation, batch fermentation, continuous fermentation, kinetics of fermentation processes

### Unit III

13 hrs

Downstream processing of biological molecules: separation of cells, foam separation, flocculation, filtration, centrifugation (Basket and bowl centrifugation), cell lysis methods, physical and chemical methods, Large scale separation techniques like Distillation, solvent



extraction, chromatography techniques, membrane filtration, ultra filtration, reverse osmosis, crystallization, spray drying, drum drying, freeze drying, whole broth processing.

Biosensors- construction and application, fermentation economics

**References:**

1. Biochemical Engineering fundamentals, Baily & Ollis Mc Gram –Hill pub
2. Chemical engineering J.M Coulson Pergamon Press
3. Comprehensive biotechnology, vol 1, 2, 3 & 4 Murray Moo Young. Pergamon Press
4. Fundamentals of biotechnology P.Prave et al WCH Weinhein pub
5. Principles of fermentation technology P.F Stanbury & Whitaker Pragmon Press



## BTS504 MICROBIAL TECHNOLOGY

No of Credits: 3

No. of Hours: 36

### Objective:

- To make the students aware of the overall industrial bioprocess so as to help them to manipulate the process to the requirement of the industrial needs.
- The course prepares the students for the bulk production of commercially important modern Bioproducts, Industrial Enzymes, Products of plant and animal cell cultures.

### Unit I

12 hrs

Microbial products: Microbial Biomass, Primary metabolites, Secondary metabolites, [Aminoacids (Glutamic acid, L lysine,) Vitamins and hormones (vitamin B12, vitamin A, riboflavin, gibberellins). Organic acids, and other industrial chemicals, (Lactic acid, acetone, glycerol). Antibiotics (Penicillin, tetracycline), Lantibiotics (peptide antibiotics)]Microbial enzymes, Transformed products. Gene cloning in microorganisms other than *E. coli* (*Salmonella*, *Rhizobium*, *Agrobacterium*, *Bacillus subtilis*, *Streptomyces*, *Aspergillus niger*)

### Unit II

12 hrs

Microbial Enzymes: Microbial production of enzymes (Protease, amylase, invertase, pectinase, xylanase) substrate, production, purification of enzymes, immobilization, their application in food and other industries

Microbial exopolysaccharides (EPS): Classification and applications (health, industrial, pharmaceutical and food); Alginate, Cellulose, Hyaluronic acid, Xanthan, Dextran, Gellan, pullulan, Curdlan, polysaccharides of lactic acid bacteria: Chitin, chitosan and chitin derivatives



Microbial beverages: Production of wine, beer and vinegar.

Microbial food : Oriental foods, Baker's yeast, cheese, SCP, SCO (PUFA) , Mushroom cultivation , sauerkraut, silage and probiotics.

Biofertilizers: *Rhizobium*, *Azotobacter*, *Azospirillum*, *Mycorrhizas*, Phosphate solubilizers

Bioconservation, biofuels, gasohol, biogas; waste utilization to generate biofuel

**References:**

1. Biotechnology in Agriculture and forestry Bajaj YPS series. Springer Verlag pub, 1986.
2. Biotechnology of higher plants-Russell ,1988.
3. Plant Cell, Tissue & Organ Culture: Fundamental Methods by O. L. Gamborg (Editor) and G. C. Phillips (Editor) (2004)J.Narosa pub.
4. Plant Biotechnology-Mantell and Smith-Cambridge univ press,1986.
5. Introduction To Plant Biotechnology/3rd Edn by Chawla H. S. (2009)
6. Plant Tissue Culture by Kalyan Kumar De (2008), Kalyani pub., Kolkata
7. Plant Tissue Culture: Theory And Practice, 5th Revised Edition (2005)  
Author: [Bhojwani S. S.](#), Elsevier Science
8. Molecular Biotechnology: Principles and Applications of Recombinant DNA Hardcover – 4<sup>th</sup> Ed. (2010) by [Bernard J. Glick](#) , [Jack J. Pasternak](#), [Cheryl L. Patten](#). American Society for Microbiology

**Skill component Identified:**

- 1) Analytical and Preparative Chromatography
- 2) Basic electrophoretic principles
- 3) Centrifuges used for separation
- 4) UV/ Visible Spectrophotometer
- 5) Chromatography – TLC , Paper Chromatography
- 6) Buffers used in Downstream Lab.



## BTS505 NANO BIOTECHNOLOGY

### Unit I

13 Hrs

Fundamentals of Nanotechnology Definitions, Relationship and Differences of Nano and Nature: Nanoscopic Colours (Butterfly Wings), Bioluminescence (Fireflies), Tribology (Geckos sticky feet, lotus leaf effect). Introduction to hydrophilic and hydrophobic materials, Nanotechnology and time line, Future perspectives of Nanotechnology and Nanobiotechnology. Classification of nanomaterials: classification of nanomaterials into 0D, 1D, 2D and 3D, Relationship between dimension and shape of nanomaterials (Quantum dots, Quantum wires, Carbon nanotubes, Bucky balls, Fullerenes).

### Unit II

13 Hrs

Synthesis methods for nanomaterials such as top to down and bottom to top, Biological synthesis method. Polymer, Nanocomposites, Supramolecular structures; DNA wires and Dendrimers., Magnetosomes, Protein based Self Assembled Nanostructure

Scopes, and applications of Biotechnology, Nanobiotechnology, Bio molecular Nanotechnology, Biomedical Nanotechnology, Green Nanobiotechnology, Nanoscale assembly of cellular components (cell membrane and liposomes).Nanoscale assembly of microorganisms (virus).Proteins, Enzymes. Nanoparticles in medicine; Types and Areas of Impact, Drug encapsulation and targeting

### Unit III

13 Hrs

Characterization techniques: confocal microscopy, scanning electron microscope, transmission electron microscope, atomic force microscope. Crystallography and spectroscopic techniques (15 h) Basics of crystal lattice, crystallinity, Bragg's law, small angle X-ray, wide angle X-ray, powder X-ray, low energy electron diffraction FTIR, UV-Vis spectroscopy, Raman spectroscopy. Photoemission spectroscopy. Difference between absorbance and surface plasmon resonanceMagnetic Characterisation techniques (15 h) Introduction to magnetism, Ferromagnetism, ferrimagnetism, antiferromagnetism, paramagnetism, effect of bulk nanostructuring of magnetic properties, Basics of magnetism, diamagnetic, paramagnetic and superparamagnetic structures



## References:

Elements of Material Science and Engineering-H. Vanvlach (4th Edition)

Nanotechnology: Principles and Practices., S. K. Kulkarni (3rd Edition) (Springer)

Fundamentals of Nanotechnolog: Gabor L. Hornyak, John J. Moore, H.F. Tibbals, Joydeep Dutta (2nd edition)(CRC Press) Buddy Ratner Allan Hoffman Frederick Schoen Jack Lemons,

An Introduction to Materials in Medicine (Elsevier publication) (3rd edition )

Gary D. Christian, Analytical Chemistry, (5th Edition), (John-Wiley & Sons, Inc.) D. A. Skoog & D. M. West,

Principles of Instrumental Analysis, (2nd Edition) (Holt Reinhart Winston), K. A. Robinsons, Chemical Analysis, (1st edition) (Harper Collins Publishers),

J. Basset, R. C. Denny, C. H. Jaffery and J. Mendhan, Vogel's Text Book of quantitative Inorganic Analysis, (5th Edition), (ELBS)



## BTOE 508: INDUSTRIAL BIOTECHNOLOGY

No of Credits: 4

No. of Hours: 36

### Objective:

- To make the students aware of the overall industrial bioprocess so as to help them to manipulate the process to the requirement of the industrial needs.
- The course prepares the students for the bulk production of commercially important modern Bioproducts, Industrial Enzymes, Products of plant and animal cell cultures

### Unit I

10Hrs

Principles of fermentation and Historical Back ground. Microbial Strain Improvement: Isolation, selection and improvement of microbial cultures; Screening of microorganisms for primary and secondary metabolites, enrichment, specific screening for the desired product. Strain improvement for the selected organism -random and strategic screening methods; Media for Industrial Fermentation: Natural and synthetic media; Media formulations-Design of fermenter, Types of fermentation process.

### Unit II.

10Hrs

Microbiological fermentation Products:- Alcohol- Ethanol, Alcoholic beverage – Wine , Beer & Whisky, Organic acids – Citric acid, Amino acids – Glutamic acid and Vitamin – B12. Microbial Production of Therapeutic Compounds :Antibiotics- production of Penicillin, Streptomycin, Tetracycline, Rifamycin and Quinolones

### Unit III

16Hrs

Enzymes in Industrial Processing: Structure, characteristics, metabolic pathways, control mechanisms. Role of cellulases, hemicellulases, Lipases – pancreatic lipases and microbial lipases, proteases – Serine proteases, metalloproteases, acid proteinases, laccases. Food Technology: Extraction, Brewing, Grain Processing, Protein Processing & Flavours, Dairy Processing, Extraction and clarification of fruit and vegetable





juices, Infusion of pectinases and b-glucosidases to alter the sensory properties of fruits and vegetables Production of fruit nectars and purees, Improving the quality of bakery products, enzymes used in meat industry. Fermented Foods - Industrial production of Yoghurt, Cheese, Tempeh. Textile Processing, Leather Processing, Paper & Pulp Processing, Immobilization techniques: Industrial techniques for whole cell and enzyme immobilization

### References:

1. Gautam, N. C., Food Biotechnology in Comprehensive Biotechnology, Vol. 6., Shree Publishers, New Delhi, 2007
2. Gutierrez – Lopez, G. F. et. al., Food Science and Food Biotechnology. CRC Publishers, Washington, 2003
3. Maheshwari, D. K. et. al., Biotechnological applications of microorganisms, IK . International, New Delhi, 2006
4. Stanbury, P. F. et. al., Principles of Fermentation Technology, 2nd Edition, Elsevier, UK, 1995
5. Waites, M. J. et. al., Industrial Biotechnology: An Introduction, Blackwell publishing, UK, 2007.
6. Bisen P.S (1994) Frontiers in Microbial Technology, 1st Edition, CBS Publishers.
7. Glaser A.N and Nilaido.H (1995) Microbial Biotechnology, W.H Freeman and Co.
8. Prescott and Dunn (1987) Industrial Microbiology 4th Edition, CBS Publishers & Distributors.
9. Prescott and Dunn (2002) Industrial Microbiology, Agrobios (India) Publishers.
10. Crueger W. and Crueger A. (2000) A Text of Industrial Microbiology, 2nd Edition, Panima Publishing Corp.
11. Stanbury P.F, Ehitaker H, Hall S.J (1997) Priciples of Fermentation Technology, Aditya Books (P) Ltd.
12. Food Fermentation – Microbiology, Biochemistry & Technology, Vol. I & II , Joshi



and Pandey.

## **BTOE 509: BIOENTREPRENEURSHIP**

**No of Credits: 3**

**No. of Hours: 36**

### **Objective:**

To learn about basis of entrepreneurship, business development

#### **Unit I**

**13 Hrs**

Innovation and entrepreneurship in bio-business Introduction and scope in Bio-entrepreneurship, Types of bio-industries and competitive dynamics between the sub-industries of the bio-sector (e.g. pharmaceuticals vs. Industrial biotech), Strategy and operations of bio-sector firms: Factors shaping opportunities for innovation and entrepreneurship in bio-sectors, and the business implications of those opportunities, Alternatives faced by emerging bio-firms and the relevant tools for strategic decision, Entrepreneurship development programs of public and private agencies (MSME, DBT, BIRAC, Make In India), strategic dimensions of patenting & commercialization strategies.

#### **Unit II**

**13 Hrs**

Bio markets - business strategy and marketing Negotiating the road from lab to the market (strategies and processes of negotiation with financiers, government and regulatory authorities), Pricing strategy, Challenges in marketing in bio business (market conditions & segments; developing distribution channels, the nature, analysis and management of customer needs), Basic contract principles, different types of agreement and contract terms typically found in joint venture and development agreements, Dispute resolution skills.

#### **Unit III**

**13 Hrs**

Finance and accounting Business plan preparation including statutory and legal requirements, Business feasibility study, financial management issues of procurement of capital and management of costs, Collaborations & partnership, Information technology. Unit IV Technology management Technology – assessment, development & upgradation, Managing technology transfer, Quality control & transfer of foreign technologies, Knowledge centers and Technology transfer agencies, Understanding of regulatory compliances and procedures (CDSCO, NBA, GCP, GLA, GMP).



## **Unit I**

**10 Hrs.**

Introduction to Nanoworld The nanoscale dimension and paradigm, Definitions and historical evolution (colloids etc.) and current practice. Nanoscience and Nanotechnology - Types of nanomaterials and their classifications (1D, 2D and 3D etc.) Nanoparticles, Nanowires, thin films and multilayer. Physical and Chemical Fundamentals of Nanomaterials, Applications in nanotechnology viz. Biosensors, separation of cells and cell organelles, drug delivery, gene therapy etc.

## **UnitII**

**12 Hrs.**

Synthesis of nanostructures: Natural in inorganic, Natural in organism, chemical and physical methods –Sol Process, Micelle, Chemical Precipitation, Hydrothermal Method, Pyrolysis, Bio-based Protocol, Chemical Vapor Deposition, Sputtering etc. Applications in various fields viz. Physical and Chemical, Materials, Life Sciences.

## **Unit III**

**14Hrs**

Functionalization of nanoparticles for biological applications, Recent trends in Nanobiotechnology. Biosensors: Concept and development of biosensors- Historical perspective. Market potential and limitations, new generations of biosensors, Biosensors in medical diagnostics. Industrial applications of biosensors

### **References:**

1. Handbook of Nanostructured Biomaterials and Their Applications in Nanobiotechnology- Hari Singh Nalwa
2. Nanobiotechnology; ed. C.M.Niemeyer, C.A. Mirkin. 9. Nanocomposite Science & Technology Ajayan, Schadler& Braun
3. BioMEMS (Microsystems)- Gerald A. Urban.
4. Introduction to Nanoscale Science and Technology (Nanostructure Science and Technology) -Massimiliano Di Ventra.



5. Nanosystems: Molecular Machinery, Manufacturing, and Computation- K. Eric Drexler.
6. Springer Handbook of Nanotechnology- Bharat Bhushan.
7. Nanobiotechnology; ed. C.M.Niemeyer, C.A. Mirkin.
8. Nanofabrication towards biomedical application: Techniques, tools, Application and impact – Ed. Challa S., S. R. Kumar, J. H. Carola.

- Preparation of Plant extract (Organic and aqueous),
- Crushing, grinding, maceration, homogenization, Filtration, Centrifugation, cold percolation extraction, hot extraction, using Soxhlet apparatus
- Synthesis of gold NPs for plants extracts
- Synthesis of Iron oxide nanoparticles by using chemical methods
- Study of FTIR spectroscopy for materials characterization
- Study of UV-Vis spectrophotometer for materials characterization
- Surface modification Nanoparticles with polymers
- Synthesis of Ag nanoparticles using sodium borohydride (Creighton's method).
- Cell counting and cell viability study
- Estimation of particle size using particle size analyser
  - Submerged and solid state fermentation
  - Estimation of microbial biomass
  - Estimation of microbial enzymes, mycotoxins, organic acids and antibiotics.
  - Microbiological assays (antibiotics, amino acids and vitamins)
  - Properties of microbial exopolysaccharides (e.g., cell immobilization )
  - Uses of Chitin and its derivatives
  - Pilot scale production of alcoholic beverages
  - Microbial interactions with plants ( rhizobia, mycorrhizas) and plant production
  - Assessment of nitrogen fixation ( acetylene reduction test )
  - Phosphate solubilization in bacteria ,fungi and actinomycetes.



- Qualities of biofuels (e.g. biodiesel , biogas)
  - Isolation of microbes of industrial importance
  - Instrumentation in bioprocess technology
  - Growth and death kinetics of microbial cultures
  - Cell encapsulation (immobilization ) techniques and uses
  - Pilot-scale production of microbial ( or plants or animal) cell products
  - Downstream processing techniques
  - Methods of cell lysis
  - Reverse osmosis
  - Drying processes
  - Biosensors



## Cleaning and sterilization methods for tissue culture

- Preparation of media, buffers
  - Maintenance of cultures, (normal and tumor cell lines )
  - Separation of peripheral blood mononuclear cells
  - Cell counting (hemocytometer)
  - Lymphocyte culture technique
  - In vitro macrophage culture from mouse
  - Preparation of human metaphase chromosomes
  - Cell viability tests
  - Cell proliferation assay
  - Growth kinetics of cells in culture
  - In vitro fertilization and embryo transfer techniques
  - Cryopreservation techniques
  - Cytotoxicity tests
- 
- Estimation of plant hormones (e.g. auxins, gibberellins)
  - Plant tissue culture methods
  - Callus culture (compact and friable)
  - Ovule and anther culture
  - Cell suspension cultures
  - Embryogenesis
  - Synthetic seeds
  - Protoplast preparation
  - Protoplast fusion techniques
  - Plant cell immobilization
  - Methods of inducing resistance through tissue culture
  - *Agrobacterium* mediated genetic transformation

\* Practical exercises to be conducted with back ground of respective theory papers (BTH 501, BTH502,BTS503 and BTS504)



## FOURTH SEMESTER SYLLABUS

<b>HARD CORE PAPERS</b>	<b>SOFT CORE PAPERS</b>	<b>OPEN ELECTIVE</b>	<b>Project/Dissertation</b>
BTH551 Immunology	BTS552 Environmental Biotechnology	Nil	<b>BTH557 :Project work &amp; Dissertation</b>
BTP555 Immunology	BTS553 Agricultural Biotechnology		
	BTS554 Food Biotechnology		
	BTP556 Environment Biotechnology & Agricultural Biotechnology/ Food Biotechnology		



## BTH551 IMMUNOLOGY

No of Credits: 4

No. of Hours: 52

### Objective:

- Concept of Immunity, types of immunity, cells & organs involved in immune functioning
- Foreign substance characteristic to evoke a immune response
- Exaggerated levels of immune response in hypersensitivity, auto immune diseases
- Briefing foundation of humoral immunity & vaccine development

### Unit I

13 Hrs

History and scope of immunology. Types of immunity-humoral and cell mediated. Innate and adaptive immunity. Specificity and memory. Primary and secondary lymphoid organs; immunization

Cells involved in immune response- T- cells,B-cells. Clonal selection theory. Lymphocyte activation, clonal proliferation, differentiation. Effector mechanisms in immunity-macrophage activation ..

### Unit II

13Hrs

**Antigens:** Definitions, antigen: Self antigens and foreign antigens, haptens, epitopes, adjuvants and mitogens. Foreign antigen's antigenicity. Protein antigens, carbohydrate antigens, bacterial cell surface antigens, blood group antigens, tumor antigens and viral antigens. Immunogens in vaccination. Bases of antigen specificity, forces of antigen. Antibody interaction, T-dependent and T-independent antigens, super antigens.

### Unit III

13Hrs

Human and mouse MHC , Transplantation immunology. HLA in human health and disease HLA tissue typing. Immune –suppression in transplantation. Hypersensitivity reaction, treatment approaches. Immunological tolerance.

Autoimmune diseases, Thyrotoxicosis, Systematic Lupus Erythromatosis, Antinuclear





antibodies. Tumour immunology-tumor antigens, immunosurveillance, Immune deficiency diseases – AIDS; Immunological tolerance.

#### **Unit IV**

**13Hrs**

**Immunoglobulins:** Isolation and purification of immunoglobulins. Structure of antibodies. Classes and subclasses of immunoglobulins, biological and chemical properties of Igs. Hyper variable region, isotopic, allotypic and idiotypic variations and idiotypic network. Biosynthesis, theories of formation, diversity of antibodies, genetics of Ig diversity, mechanisms contributing to antibody diversity, Ig genes, isotype switching, Ag-Ab reactions, specificity, affinity binding of antibodies.

**Vaccines: Immunization:** Active immunization, passive immunization. Adverse reactions from vaccines, experimental immunization procedures, production of recombinant vaccines and their uses.

**Transplantation Genetics and Immunology:** Types of grafts, major histocompatibility gene complex, ABO blood group compatibility, host response to transplantation, immunosuppressive therapy.

#### **References:**

1. Jordan S.Pober Cellular and molecular immunology. – Abdul K.Abba, Andrew H. Lichtman, Saunders Co
2. Essential immunology- Ivan Riott 8<sup>th</sup> edition Blackwell scientific pub
3. Handbook of expt. Immunology vol. 1,2 .Wiler DM Blackwell scientific pub.
4. Immunology –Janis Kuby; Freeman and co publishers, 2000
5. Immunology-3<sup>rd</sup> Edition .Ivan Riott , Jonathan Brostoff and David Male. Mosby publishers
6. Immunobiology-3<sup>rd</sup> edition, Janeway and Travers .Churchill Livingstone publications
7. Practical Immunology. Hudsonetal Blackwell scientific pub., 1986

#### **Skill component identified :**

Antigen and antibody reactions employed in diagnostics

Antibody purification methods

Immune cell structure/function and molecular basics and techniques of immunology .



## BTS552 ENVIRONMENTAL BIOTECHNOLOGY

No of Credits: 3

No. of Hours: 36

### Objective:

- Understand the interactions between organisms and their environments, and the consequences of these interactions in natural populations, communities, and ecosystems evidenced by pollution.
- To learn the extent of pollution in different industries including agriculture by analyzing the permissible limits and indices of different pollutants
- Prevention of such bio-hazardous and chemicals accumulation in the environment using novel biotechnological methods using microorganisms and plants
- Consequences of genetically modified organisms and their impact on natural environment, rules and regulations while handling these organisms, issues of aquaculture industries and prevention.

### Unit I

14 Hrs.

Environmental pollution; Soil, water and air pollution; Indicator organisms and human pathogens (*Salmonella*, *Vibrio*, *Hepatitis A*)

Microbial degradation of toxic chemicals (pesticides, detergents, plastics). Degradation of organic compounds (cellulose, lignin, hydrocarbons: aliphatic, aromatic, alicyclic hydrocarbons)

Microbial deterioration of leather.

Microbial mining (copper, gold, iron), microbial influenced corrosion and remedies, bioaccumulation, biomagnification.

### Unit II

14 Hrs

Principles of microbial bioremediation, *in situ* and *ex situ* bioremediation, microbiological



treatment of solid wastes- composting, land farming, bioreactors. Biological treatment of liquid wastes - aerobic and anaerobic treatments sewage and effluent treatments.

Pollution control measures, international and national pollution regulatory acts; Permissible limits and indices for pollutants; Hazardous wastes: microbial processing and disposal of dyes & paints, radioactive wastes, pharmaceuticals, refinery, distillery and leather industry effluents.

### **Unit III**

**8 Hrs.**

Coastal regulatory zone (CRZ). Environmental issues of aquaculture; Biofilms and Biofouling – micro fouling and macro fouling; Biomaterials; Biomolecules from the sea; Issues associated with environmental release and monitoring of GMOs.

#### **References:**

1. Ecology- Odum
2. Environmental Biotechnology, Jogdanand ,Himalaya pub House
3. Environmental and Biochemistry Kudesia&JetleyPragathiPrakashan pub.
4. Microbial Ecology- Atlas and Bartha
5. Microbial Biotechnology- Alexander.G, WH Freeman and com.
6. Sewage and industrial effluent treatment John Arundel ,Blackwell science pub
7. Soil Microbiology,4<sup>th</sup> ed. N.S. Subba Rao ,Oxford & IBH pub.
8. Waste water engineering 3<sup>rd</sup>ed Metcalf &Eddy ,McGraw –Hill international Eds.

#### **Skill component Identified**

The course content aims to make the students understand how biotechnology can help in monitoring or removing the pollutants and developing an understanding of new trends such as biofuels, renewable energy sources or microbial technologies which can minimize the harmful impact of pollutants in the environment.



## BTS553 AGRICULTURAL BIOTECHNOLOGY

No of Credits: 3

No. of Hours: 36

### Unit I

10 Hrs.

Bioinoculants Introduction and Importance of biofertilizers in agriculture, Mass culturing and quality control of microbial inoculants-mother culture, shake culture and large scale production of biofertilizers (Rhizobium, Azotobacter, Mycorrhiza, Actinorhiza) types of carrier materials, packing storage, shelf life and transportation of biofertilizers. Methods of application to seed, soil and nursery. Vermiculture, composting , current practices and production.

Biopesticides: *Bacillus thuringiensis, Trichoderma, Baculoviruses*

### Unit II

16 Hrs.

Integrated pest management. Breif introduction to entomology: Importance of JH and JH analogues in insect pest control. Insect pheromones and their applications. Biological control of insect pests and weeds using natural enemies, mass multiplication of predators and parasites. Biological control of plant pathogens using antagonistic fungi and antagonistic bacteria.

### Unit III

10 Hrs.

Applications of Biotechnology in Animal husbandry Introduction and importance of animal husbandry. Applications of biotechnology in poultry, aquaculture, sericulture, Improvement of poultry, disease resistance, recombinant vaccines for poultry, growth hormones for increasing biomass, fish breeding techniques, silkworm as bioreactor for the production of commercially important proteins ; improvement of livestock, molecular pharming of products - (Pharmaceuticals through milk or genetically engineered cows).



## BTS554 FOOD BIOTECHNOLOGY

**No of Credits: 3**

**No. of Hours: 39**

### **Objective:**

To enable the students

- To know about the constituents and additives present in the food.
- To gain knowledge about the microorganisms, which spoil food and food borne diseases.
- To know different techniques used for the preservation of foods

### **Unit-I**

**13Hrs**

Fermented foods, milk-based products, fermented vegetables, fermented meats, fish, beverages, vinegar, mould fermentation - tempeh, soy sauce, rice wine. Enzymes in dairy industry, cheese making and whey processing, impact of enzyme technology (bioethanol, protein hydrolysates, bioactive peptides), Enzymatic processing of fruit juices; role of enzymes in baking, meat and meat processing, phytase in animal feeds, DNA-based methods for food authentication, comparative methods of toxicity testing in (novel) foods, biological approach to tailor-made foods, catabolic processes and oxygen-dependence reactions in food, application of generic technologies in food and nutritional sciences; anti-cancer components in foods.

### **Unit-II**

**13Hrs**

Functional foods and Biotechnology: Biochemical processing in the improvement of functional foods with targeted health benefits and increased nutrient value; applying molecular, biochemical, cellular and bioprocessing concepts, bio-mobilization of major nutrients such sterols, lipids, vitamins and minerals, use of specific phenolic metabolites from botanical species. Pre- and Pro-biotics, single cell protein, single cell lipids. Manipulation of fruit ripening process.

### **Unit III**

**13Hrs**

Food processing, principles and practices, food ingredients and processing aids from biotechnological processes, corn sweeteners, bacterial starter cultures, cold-adapted



enzymes. Food spoilage, preservation, mycotoxins in food commodities. Genetically modified foods, designer foods, Nutraceuticals, detection of GM foods.

**References:**

1. W.C. Frazier And D.C. Westhoff – Food Microbiology, 4th Ed., Mcgraw-Hill Book Co., New York 1988.
2. J.M. Jay – Modern Food Microbiology, Cbs Pub. New Delhi, 1987
3. T.P. Coultate – Food – The Chemistry Of Its Components, 2nd Edn. Royal Society, London, 1992.
4. B. Sivasanker – Food Processing And Preservation, Prentice-Hall Of India Pvt. Ltd. New Delhi 2002



- Study of immune system in rats
  - Blood film preparation and study of immune cells
  - Histology of organs of immune system
  - Study of insect hemocytes
  - Production of antiserum
  - Isolation of lymphocytes
  - Antigen-antibody reactions (*in vitro*)
  - Phagocytosis (*in vitro*)
  - Immunodot technique
  - Immunodiffusion technique
  - Immunological diagnosis of pregnancy and infection
  - Demonstration of ELISA technique
- 
- Production of Compost (methods)
  - Vermicompost and its analysis
  - Cultivation of mushrooms
  - Biogas (biofuels) production
  - Waste water treatment methods
  - Solid water treatment methods
  - Experiments of biofouling and biofilms
  - Experiments on industrial waste treatment methods (e.g. distillery, whey)
- 
- Bioinoculants : Isolation and mass production of: Rhizobium, Azospirillum,
  - Azotobacter, Anabena, and Azolla
  - Isolation of phosphate solubilizing microorganisms from soil sample.
  - Estimation of phosphate by Fiskay-Subbarao method.
  - Detection and quantification of mycorrhizae by root clearing technique from different crop plants.
  - Study of root /stem nodules and study of VAM.
  - Assay of Biofertilizers (at least three types).
  - Testing of antagonism by dual culture plate technique.
  - Testing of antimicrobial property of antagonists culture filtrate.
  - Bio-insecticidal effect of biopesticides from microbial and plant sources.
  - Protoplast fusion in Rhizobium for enhanced nodule formation.
  - Baculovirus stocks –Preparation and titration using plaque colony.
  - Co-transfection of insect cells using linearized baculovirus stocks.
  - Induced breeding of commercially important fishes.



Code No. of the paper

Reg. No.

**Question Paper Format**  
**M.Sc. BIOTECHNOLOGY**  
**(TITLE OF THE PAPER)**

**Time: 3 Hours**

**Max.Marks:70**

**PART A (Any Five)**

**(5 x4=20)**

- 1.
- 2.
- 3.
- 4.
- 5.
- 6.

**PART B (Any Five)**

**(5x6=30)**

- 7.
- 8.
- 9.
- 10.
- 11.
- 12.

**PART C**

**(2x10=20)**

- 13.
- 14.
- 15.
- 16.





**SEMESTER EXAMINATION, MONTH YYYY**  
**MSc. BIOTECHNOLOGY**  
**BT-#: TITLE OF THE PAPER**

**TIME: 5Hr**

**MARKS: 70**

I.	Major experiment A(Principle, Procedure, Conducting , Result & Discussion)	25
II.	Minor experiment B(Principle, flow chart, conducting , Result & Discussion)	15
III.	Spotter C, D, E & F	10
IV.	Class Record	10
V.	VIVA	10

