

**TECHNICAL UNIVERSITY  
KOTA (RAJASTHAN)  
BIOTECHNOLOGY  
SCHEME OF STUDIES AND SYLLABUS FOR B. TECH BIOTECH**

**Semester III (Theory Scheme)**

Code	Name of subject	Weekly load, hours			Max sessional marks	Exam Dur Hrs	Exam max marks
		L	T	D/P			
3BT.1	Microbiology	3			20	3	80
3BT.2	Cell biology	3			20	3	80
3BT.3	Molecular Biophysics	3	1		20	3	80
3BT.4	Fluid Mechamics Operation	3	1		20	3	80
3BT.5	Material and Energy Balance	3	1		20	3	80
3BT.6	<b>Elective (Any one of the following)</b>	<b>3</b>			20	3	80
3BT6.1	Environmental Studies						
3BT6.2	Dairy Technology						
3BT6.3	Neurobiologys						
	<b>TOTAL</b>	<b>18</b>	<b>3</b>		<b>120</b>		<b>480</b>

**Semester III (Practical Scheme)**

S.NO	Code	Subject	S	P	Marks	
					Internal	External
1	3BT.7	Microbiology lab		3	60	40
2	3BT.8	Cell biology lab		3	60	40
3	3BT.9	Unit Operation lab		3	45	30
4	3BT.10	G.D. & Seminar		2	45	30
5	3BT.11 (BTDC)	Discipline and Extracurricular activity			--	50
	<b>Total</b>			<b>11</b>	<b>210</b>	<b>190</b>

## **COURSE: MICROBIOLOGY**

**Unit I:- General Introduction-** History and development of microbiology; Discovery of microbial world; experiments of Pasteur; Era of the discovery of antibiotics; Haeckel's three kingdom classification; Whittaker's five kingdom classification Algae, fungi, mycoplasma, viruses. Basic concept in Taxonomy, Classification of microorganisms. Bergey's manual of determinative bacteriology.

**Unit II:- Bacteriology, DNA homology and Numerical taxonomy-** Morphology and ultra structure of bacteria; morphological types; Cell Wall- Archaeobacteria; gram positive and gram negative differentiation; Structure and function of cilia & flagella; Nucleoid, carboxysomes, plasmids; Bacterial spores- their structure, properties, formation and germination.

**Unit III:- Bacterial Genetics, Diversity of Bacterial nutrition and Enumeration of microbes** — Conjugation, transformation & transduction, plasmids and their properties Autotrophic, heterotrophic; Culture media; Total cell count; Isolation; Identification of microbes, Selective culture techniques; Fungi culture techniques; Animal Cell and tissue culture.

**Unit IV:- Growth of microbial population :**Batch culture; Continuous culture of microbes; Growth curve- aerobic and anaerobic; Effect of environment, temperature, pH, radiation and atmosphere on microbial growth; synchronous and asynchronous growth, enumeration of multiplying microorganism, Virus-plaque assays.

**Unit V:- Microbial Metabolism and Environmental Microbiology -** Metabolic pathways and bioenergetics; production of secondary metabolites, their application in industry; Food Spoilage and preservation: Recycling of biomaterials; production of Biogas; bio-fertilizers; biopesticide; pollution control through use of consortium of microorganism.

### **Books Recommended:**

1. Microbiology- Prescott & Dunn.
2. General Microbiology by Brock.
3. Microbial Physiology 4th ed. By Alber G.Moat & John W.Foster Wiley.
4. Microbiology by Pelczar- M.J.Chan ECS & Krieg NR-Tata Mcgraw Hill
5. Foundation in Microbiology-by Talaro K, Talaro A, Cassida Pelzar and Reid W.C.Brown Pub.
6. General Microbiology by R.Y.Stanier.

## CELL BIOLOGY

**Unit I:- Cell Theory; Prokaryotic and Eukaryotic organization-** Nucleus and Nuclear pore complex; Mitochondria; ER; Golgi complex and other membrane bound cell organelles; Cell as a macromolecular assembly; Cellular compartmentalization, Organelle architecture.

**Unit II:- The Nucleus and the Cell cycle division-** Chromosomal DNA and its Packaging; Structure of Chromosomes; Basic idea of DNA Replication, Transcription and post transcriptional modifications; Cell Cycle- Mitosis & Meiosis; Checkpoints of the cell cycle.

**Unit III:- Cytoskeleton & Cell communication-** Nature of the Cytoskeleton; Microfilaments, Intermediate Filaments, Microtubules, Cilia and Centrioles, Actin Filaments; Actin-binding Proteins, Muscle; Cell Junctions, Cell - Cell Adhesion, Extra cellular Matrix and Extra cellular Matrix Receptors, Integrins; Cell Wall.

**Unit IV:- Membrane Structure, Transport of Molecules and Membrane Excitability-** The Lipid Bilayer, Membrane Proteins, Principle of Membrane Transport, Uniport, symport & Antiport- Na/K ATPase, Ca ATPase, GLUT1; Endocytosis and exocytosis; Carrier Proteins and Active Membrane Transport, Ion channels and Electrical Properties of Membranes.

**Unit V:- Cell Signaling-** General Principle of Cell Signaling; Signaling via G-Protein linked Cell Surface Receptors; Signaling via Enzyme-linked Cell Surface Receptors; Kinase Receptors; Structural Features of Trans-membrane Receptors; Hormone Receptor; Secondary messengers.

**Cancer:** Cancer as a Micro evolutionary Process, Tumor cells, Proto-oncogenes and viral oncogenes, Tumor suppressors genes.

### Text / Reference Books

1. Cell as a Molecular Approach- Bruce Alberts
2. The Cell- Geoffery M.Cooper
3. Cell & Molecular Biology by H.Baltimore, WH Freeman, Lodish & Berk
4. Cell Biology by Kimball T.W. Wesley Pub.
5. Cell Biology- Gerald Karp
6. Cell & Molecular Biology by De Robertis, Lea and Febiger

## Molecular Biophysics

### UNIT-I

**Levels of molecular organization.** Composition of primary structures of proteins and nucleic acids, Hydrogen bonding, hydrophobic interactions, ionic interactions, disulphide bonds and their role in proteins structure and nucleic acid structure

### UNIT-II

**General characteristics of protein structure and functions.** Ramachandran or steric contour diagram and potential energy calculation of proteins, secondary structural elements and organization of tertiary structure, zipper model, method for structural elucidation, aspects of protein folding, protein-protein interactions, Scat chard plot, cooperative interactions, the Hill constant and linked functions.

### UNIT-III

**General characteristics and structure of nucleic acid,** steric hindrances, conformational properties of bases, stabilizing order forms, base stacking interactions, A, B and Z type double helices, tRNA structure, secondary and tertiary structure, higher organization of DNA, protein nucleic acid interactions

### UNIT-IV

**Micelle and bilayer formation,** studies of bilayer structure and function, liposomes, order disorder transitions, interferences, transport across membranes (the Nerst Planks approach and rate theory of transport).

### UNIT-V

**Photochemical and photobiological phenomena,** mechanism of photosynthesis, vision, absorption and fluorescence.

#### **Books Recommended :**

1. C.R. Cantor and P.R. Schirmer, Biophysical Chemistry (Parts 1 and 3). W.H. Freeman, 1980.
2. G. Schuiz and R.H. Shrimmer, Principles of protein structure. Springer Verlag, 1984.
3. W. Saenger, Princiles of Nucleic acid structure.
4. B.L. Siler, Physical Chemistry of Membranes : An introduction to the structure and dynamics of biological membranes. Allen and Unwin and the Solomon Press, 1985

## Fluid Mechanics Operation

### UNIT-I

**Nature of fluid**, viscosity, Laminar-flow, Turbulent flow, steady flow, Prandtl Boundary Layer, Velocity gradient, Hagen Poiseuille's equation, Bernoulli Equation. friction from changes in velocity or direction, Resistance of immersed bodies. Friction in flow through packed beds.

### UNIT-II

**Flow measurements**, Orifice and Venturi meters, Pilot tube, Rotameter and other types of meters, transportation of fluids, pipe fittings and valves, pumps, fundamentals of fluidisation.

### UNIT-III

**Principles of comminution**, types of comminuting equipment energy and power requirement, crushers, grinders, mixing, types of mixing, power consumption in mixing and agitation.

### UNIT-IV

**Mechanical separation**, screening, types of screen, filtration principle, constant pressure and constant rate filtration, settling classifiers, floatation principle of centrifugal separations types of centrifuge and industrial application of centrifuge.

### UNIT-V

**Drying**, principle and method of drying, types of dryer, fluidised bed dryers, rotary drum dryers, vacuum dryers.

### Books Recommended :

1. McCabe, Smith & Harriot, Unit Operations of Chemical Engineering TMH 5<sup>th</sup> edition.
2. Geankoplis, Transport Processes & Unit Operations PHI 3<sup>rd</sup> edition.
3. Coulson & Richardson, Chemical engineering Vol. I and II Butterworth Heinemann.
4. Badger, W.L. Bachero, J.T., Introduction to Chemical Engineering MGH.
5. Foust A.S. Wenzel, L.A. et.al Principles of Unit Operations 2<sup>nd</sup> edition, JWS.
6. Perry, Chilton & Green, Chemical Engineers Handbook, MGH.

## Material and Energy Balance

### UNIT-I

**Introduction to Chemical Engineering Calculations :** Units and dimensions, the mole unit, conventions in methods of analysis and measurement, basis, temperature, pressures, the chemical equation and stoichiometry.

### UNIT-II

**Gases, Vapours, Liquids and Solids :** Ideal gas law calculations, real gas relationships, vapour pressure and liquids, saturation, partial saturation and humidity introduction to vapour-liquid equilibria for multicomponent systems, material balances involving condensation and vaporization.

### UNIT-III

**Material Balances :** Material balance of physical processes with and without chemical reaction, including recycle, purge and bypass.

### UNIT-IV

**Energy Balances :** Concept and Units, calculation of enthalpy changes, general balance with and without reactions, heats of solution and mixing, Unsteady-state material and energy balances.

### UNIT-V

**Solids, liquids and gaseous fuels:** Some industrial examples of the above, simple estimation of physical properties (transport, thermodynamic) of fluids and mixtures. Calorific values of fuels, Air Requirement of fuel gases and combustion calculation.

### Books Recommended :

1. Himmelblau, D.M., "Basic Principles and Calculation in Chemical Engineering," 6th Ed., Prentice-Hall of India.
2. Bhatt and Vora, "Stoichiometry," 3rd Ed., Tata McGraw-Hill, New Delhi.
3. Hougen, Watson and Ragatz, "Chemical Process Principles," Vol. 1, Asia Publishing House, New Delhi.
4. Saha, S.N., "Fundamentals of Chemical Engineering," Dhanpat Rai Publishing Co., New Delhi, 2000.

## 3BT.6.1: ENVIRONMENTAL STUDIES

### UNIT-I

**Multidisciplinary nature of Environmental studies :** Definition, scope and importance ó Need for Public Awareness. Natural Resources : Renewable and non-renewable resources ó Natural resources and associated problems ó Forest resources ó Use and over exploitation, deforestation, ó Mining, dams and other effects on forest and tribal people ó Water resources ó Use and over utilization of surface and ground water ó Floods, drought, conflicts over water, dams ó Mineral resources : Use and exploitation, environmental effects of extracting and using mineral resources.

**Energy resources** : Growing energy needs, renewable and non-renewable energy sources use of alternate energy source : Growing energy needs, Land resources : Land as a resource, land degradation, man induced landslides, soil erosion and desertification. Solid Waste Management : Causes, effects and control measures of urban and industrial wastes. -Disaster management : floods, earthquake, cyclone and landslides.

### UNIT-III

**Biodiversity and its conservation** : Introduction ó Definition : genetic, species and ecosystem diversity. Bio-geographical classification of India ó Value of biodiversity : consumptive use, productive use, social ethical, aesthetic and option value. Biodiversity at global, National and local levels. India as a mega-diversity nation ó Hot spots of biodiversity ó Threats of biodiversity : habitat loss, poaching of wildlife, manwildlife conflicts. - Endangered and endemic species of India ó Conservation of biodiversity : In situ and Ex-situ conservation of biodiversity.

### UNIT-IV

**Social issues and the environment** : From Unsustainable to Sustainable industrial development-urban problems related to energy ó Water conservation, rain water harvesting, watershed managementó Environmental ethics : issues and possible solutions. ó Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Wasteland reclamation.ó Environment Protection Act. ó Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act ó Wildlife Protection Act ó Forest conservation Act.

### UNIT – V

**Human Population and the Environment** : Population growth, variation among nations. Population explosion ó Family Welfare Programme. ó Environment and human health. ó Human Rights. ó Value Education. ó HIV/AIDS. ó Women and Child Welfare. ó Role of Information Technology in Environment and human health.

### Book Recommended :

1. Text book of Environmental Studies for Undergraduate courses by Erach Bharucha for University Grant Commission.
2. Environmental Science by David Botkin.
3. Environmental Studies by Anil Kumar Dey.
4. Environmental Pollution Engineering and control by C.S.Rao.
5. Environmental Pollution by K.C. Agarwal.
6. A text book of Ecology and Environment by P.C.Joshi.
7. Environmental Education by N.S.Bais.
8. Environmental Biotechnology by P.D.Sharma.



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## 3BT6.2: DAIRY TECHNOLOGY

### UNIT-I

**Milk** : Definition, Composition, Chemical and functional properties of milk components: physicochemical properties of milk protein, aggregation of Casein, micelles, factors affecting milk composition, milk secretion and lactation.

### UNIT-II

**Micro-organisms**: importance in dairy science and technology. microbial spoilage of milk, hydrolytic rancidity in milk and milk products, autooxidation of milk fats and effects on milk quality.

### UNIT-III

**Milk processing operations**: Milk pasteurization, Homogenization & Sterilization. Effect of processing of milk components and their functional properties.

### UNIT-IV

**Skimming of milk**, Cream & Cream characteristics, manufacture of yoghurt and other fermented milk products, Ice cream manufacture, Butter making technology, technology of cheese, processing of concentrated milks and dried milk powder.

### UNIT-V

**Milk quality control**, sanitation in the dairy plant, adulteration of milk, dairy equipment maintenance and waste disposal.

#### **Books Recommended :**

- 1 Outlines of Dairy Technology by Sukumar De, Oxford University Press.
- 2 Milk and Milk Products by Eckles, Combs and Macy, Tata McGraw Hill.
- 3 Technology of Indian Milk Products by Aneja et al. A Dairy India Publication.
- 4 Principles of Dairy Processing by James N. Warner, Wiley Eastern Ltd.



## 3: NEUROBIOLOGY

### UNIT-I

Cytology of neuron, properties of neuron resting membrane potential Functional consequences of passive membrane.

### UNIT-II

Voltage gated channels and generation of action potential.

### UNIT-III

Principles underlying electrical and chemical synaptic transmission Factor controlling transmitter release morphology of chemical synapse and pattern of inter connections.

### UNIT-IV

Chemical messengers and small molecules and peptides Gaseous signals and response of brain, molecular steps in synaptic transmission.

### UNIT – V

Molecular aspect of postsynaptic receptor, NMDA receptors, long term potentiation Molecular biology of learning Reaction of neuron to injury.

### Books Recommended :

- 1 Human Physiology by C.C. Chatterjee, Vol. 1 & 2. Medical Allied Agency, Calcutta.
- 2 Anatomy and Physiology in Health and Disease. K.J. W. Wilson and A. Waugh Churchill and Livingston.
- 3 The Biochemistry of Cell signaling. Ernest, J.M. Helmrich, Oxford Press.

## Biotechnology, IV Semester

S.NO	Code	Subject	L	T	Exam Hrs	MM Internal + End term
1	4BT.1	Molecular Genetics	3		3	20+80
2	4BT.2	Analytical Techniques in Biotechnology	3		3	20+80
3	4BT.3	Developmental Biology	3		3	20+80
4	4BT.4	Thermodynamics of Biological System	3	1	3	20+80
5	4BT.5	Bioenergetics . I	3	1	3	20+80
6	4BT.6	Elective. II (Any one of the following	3		3	20+80
7	4BT.6.1	Biopharmaceuticals				
8	4BT.6.2	Impact of Science & Technology on Society				
9	4BT.6.3	Waste Management				
		<b>Total</b>	<b>18</b>	<b>2</b>		<b>600</b>

## Semester IV (Practical Scheme)

S.NO	Code	Subject	P	Marks	
				Internal	End term
1	4BT.7	Molecular Genetics	3	60	40
2	4BT.8	Analytical Techniques in Biotechnology	3	45	30
3	4BT.9	Developmental Biology	3	45	30
4	4BT.10	Bioenergetics . I	3	60	40
5	4BT.11	Discipline and Extracurricular activity			50
	Total		12	210	190

### 4BT.1: MOLECULAR GENETICS

#### BT-401

#### UNIT-I

Mendel's Laws of Inheritance, Deviations of Mendel's Laws, sex linked inheritance, Polygenic and Maternal inheritance.

#### UNIT-II

Chromosome structure and replication, DNA Structure, DNA Replication (Prokaryotic and Eukaryotic), Inhibitors of DNA replication, Mutation- elementary concept, Types of mutations, Point mutation (Base pair change, frame shift, deletion, inversion, insertion etc.)

#### UNIT-III

Structure and functions of m-RNA, r-RNA and t-RNA, Transcription apparatus, Transcription in eukaryotes and prokaryotes, post transcriptional processing of RNA's (t-RNA, r-RNA, m-RNA). Inhibitors of transcription, reverse transcription

#### UNIT-IV

The genetic code and its features, deciphering of genetic code, protein synthesis in prokaryotes and eukaryotes, post translational modifications.

rearrangement and amplification.

Books Recommended:

1. Molecular Genetics of Bacteria by Larry synder and wendey champness, ASM press, Washington, 1997.
2. Genetics by Goodenough U, Hold Saunders International, 1985.
3. Principles of Genetics by Gardner, E.J., Simmons M.J.slustad DP.
4. Geneø VIII by Benajmin Lewin, oxford University press, oxford NY.
5. Molecular Biology by Freielder D.,Jones and Barilett pub. Inc,
6. Concepts of Genetics, Klug & Cummings, Prientice Hall.

## 4BT.2: ANALYTICAL TECHNIQUES IN BIOTECHNOLOGY

### Unit I:

**Microscopy**- Microscopic identification of various microorganisms; phase contrast and confocal microscopy; SEM-TEM microscopy.

### Unit II:

**Electrophoretic Techniques**- Basis and principle of Electrophoresis; Electrophoresis of proteins and nucleic acids; 1D & 2D Gels; pulsed field electrophoresis; capillary electrophoresis; western southern and northern blotting; dot and slot, gel documentation.

### Unit III:

**Methods of biochemical analysis**- Carbohydrates, lipids, proteins and nucleotides analysis; enzymatic assays of various metabolites; DNA purification and PCR-based analysis; DNA fingerprinting; DNA sequencing.

### Unit IV:

**Immunological Techniques**- Antiserum production, immunofluorescence, immunohistocompatibility ELISA; localization of cells in tissues immunoblotting; monoclonal antibodies.

### Unit V:

**Spectroscopy**- UV-Visible spectroscopy, infrared-spectroscopy, NMR & Mass spectroscopy; Principle and application.

omatography, Adsorption chromatography, Affinity application in biotechnology).

## References:

- a. Biochemical techniques- Wilson & Walker.
- b. Biochemical techniques- David Freilfelder
- c. D.Holem and H.Peck;Analytical Biochemistry.Longman,1983.
- d. T.G.Cooper;The Tools of Biochemistry.Wiley Intersciences,1997.
- e. R.Scopes, Protein Purification :Principles and Practices.Springer Verlag, 1982.
- f. Selected readings from Methods in Enzymology,Acadernic Pres

## 4BT.3: DEVELOPMENTAL BIOLOGY

### Unit I:

**Basic concepts-** Cell fate and commitment, its mechanism, mosaic and regulative development, maintenance of differentiation, pattern formation and compartments, Apoptosis, Senescence and Ageing.

### Unit II:

**Morphogenesis-** model organism, developmental mutantsnts, Transgenic organism in development, cellular and microsurgical techniques, Genes and their role in development, signal transduction in development cell division cycle,cytoskeleton.cell adhesion and the extra cellular matrix.

### Unit III:

**Unicellular models-** sporulation in *Bacillus subtilis*- Mating type switching in yeast aggregation and culmination in dicyostelium discordeum, Sex gametes and fertilization-germ line speciation, germ cell migration,gametogenesis,gastrulation in invertebrate and vertebrate, cell lineage, Axis specification in vertebrates, fate of ectoderm, measoderm and endoderm.

### Unit IV:

**Cell differentiation mechanism and factors affecting it-** Developmental gradients in hydra, axial gradients in Drosophila development, Organogenesis in invertebrates and vertebrates,

development of plant embryo, development of seeding, root, shoot, leaf and flower, plant versus animal development

### **Books Recommended:**

1. Developmental Biology by Gilbert S.
2. R.M.Twyman 2001 Developmental Biology. Viva books private Ltd. New Delhi.
3. Developmental Biology-5th edition, sineaur Associate Inc.Slack JMV 1991,From egg to embryo,Second edition Cambridge University Press U.K.
4. Wolpert L.1997,Principles of development.Oxford University Press.Oxford University

## **4BT.4: THERMODYNAMICS OF BIOLOGICAL SYSTEMS**

### **UNIT I:**

Energy, thermodynamics and living processes - an introduction Energetic processes in the biosphere: The ecosystem.

Thermodynamics systems: equilibrium, activity coefficients and phase equilibrium functions of state, cyclic processes, work, energy and metabolic heat; Mechanical equivalent of heat, energy as a function of state.

### **UNIT II:**

The laws of thermodynamics: Second law; Reversible vs. irreversible processes entropy, work; Combination of the first and second law, Free energy, useful work and delta G. Entropy:, Probabilistic nature of Entropy, Order and Disorder.

### **UNIT III:**

Biological systems as open, non-equilibrium systems: failure of classical thermodynamics in describing biological processes, Standard free energy changes and equilibrium constants, direction and rate.

### **UNIT IV:**

Chemical potential: Visualization of the potential velocity and steady flow; Fick's law and diffusion. Local Equilibria and steady state: Energy vs. Power; Transducers in biological states, Constitutive equations.

### **UNIT V:**

Non-equilibrium thermodynamics, First and second law, The electrochemical potential, External forces an steady state, Fick's Law, chemical reactions in the steady state, internal entropy production, cells as non-equilibrium stationary states; Diffusion and membrane transport. Thermodynamic analysis of oxidative photophosphorylation, stability of non-equilibrium stationary states, ordering in time and space far from equilibrium, glycolytic oscillations, biological clocks and biological rhythm.

- 1 Bioenergetics, A.L. Lemmingel, W.A. Benjamin Inc.
- 2 Biological Thermodynamics, D.T. Haynie, Cambridge University Press.
- 3 Biophysical Chemistry, C.R. Cantor and P.R. Schimmel, Freeman
- 4 Physical Chemistry: Principles and Applications in Biological Sciences, I. Tincoco, K.Sauer and J.C. Wang, Prentice Hall College Division.
- 5 Physical Chemistry for the Chemical and Biological Sciences, R. Chang, University Science Books
- 6 Thermodynamics and Kinetics for the Biological Sciences, G.G. Hammes, John Wiley and Sons Inc.

## 4BT.5 : BIOENERGETICS- I

**Unit I:-Biochemical Evolution-** Classical evolution of Nitrogenous bases and amino acids; Evolution of Enzyme Systems; Classical experiments based on it; Biochemistry of water.

Amino Acids, Peptides and proteins- Structure, properties, classification and functions of amino acids, amino acid sequence determination, structure and function of proteins, Protein denaturation and renaturation, folding pathways, folding accessory proteins, Separation techniques based on their structure and properties, Clinical Significance.

**Unit II:- Carbohydrates-** Definition; Basic structure; Mono and Polysaccharide; properties and functions of monosaccharides and related compounds; structural polysaccharides- cellulose and chitin; storage polysaccharides- starch, glycogen; peptidoglycan and glycosaminoglycans; proteoglycans and glycoproteins; Separation and Characterization Techniques; Clinical significance.

**Unit III:- Lipids-** Structure and Classification of lipids; Functions; nomenclature; physical and chemical properties of fatty acids; general structure and functions of triacylglycerols; Phospholipids, sphingolipids, glycolipids, cholesterol & lipoprotein structures; properties and functions of steroids; Separation and Characterization Techniques; Clinical Significance.

**Unit IV:- Enzymes-** Definition; Nomenclature and classification; Co-enzymes, co-factors & prosthetic groups; Reaction and derivation of Michaelis-Menten equation, Lineweaver-Burke plot, Enzyme inhibition; Allosteric regulation of enzymes, Isozymes; Mode of catalysis.

Biochemical Energetics- Energy Yielding and Energy Requiring Reactions; Oxidation-Reduction Reactions, Electron transport chain and oxidative phosphorylation; ATP Yield; Photo-phosphorylation, Active and Passive transport.

**Unit V :- Vitamins and Hormones-** Structure, properties and biological functions of vitamins; Chemistry, properties and biological functions of plant and animal hormones.

**Books Recommended :**

1. A.L. Lehninger, D.L. Nelson, M.M. Cox, Principles of Biochemistry, 3<sup>rd</sup> Edn., Worth Publishers.
2. Biochemistry by Lubert Stryer. W. H. Freeman & Company, NY.
3. G. Zubay, Biochemistry, 4<sup>th</sup> Edn., McGrawhill Publishers.
4. Biochemistry- Stump & Cohn
5. Biochemistry Voet and Voet 6. Biochemistry Garrett & Grasim.

## **4BT6.1: BIOPHARMACEUTICALS**

### **UNIT-I**

History and definition of drugs, sources of drugs . plants, animals and microbes, crude drugs- Scope and Importance, Classification (Taxonomical, Morphological, Chemical Pharmacological); Role of biopharmaceuticals in treatment of various health disorders.

### **UNIT-II**

Cultivation and utilization of medicinal and Aromatic Plants in India. Genetics as Applied to Medicinal Herbs.

### **UNIT-III**

Methods of Drug evaluation (Morphological, Microscopic, Physical and Chemical). Preliminary screening, Assay of Drugs . Biological evaluation/assays, Microbiological methods. Chemical Methods of Analysis : Chemical estimation, spectrophotometry and Fluorescence analysis.

### **UNIT-IV**

Glycosides, Tannins, Volatile Oils, Alkaloids, Flavonoids, Resins-Extraction Methods and Manufacturing practices.

### **UNIT-V**

Production of therapeutic proteins, hormones, cytokines . interferon, interleukins I and II, tumor necrosis factor (TNF).





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**Books Recommended :**

- 1 Pharmacognacy, C.K. Kokate, A. P. Purohit, S.P. Gokhle (1996), Nirali Prakashan, 4<sup>th</sup> edition.
- 2 Natural Products in Medicine : A Biosynthetic Approach (1997), Wiley.
- 3 Biopharmaceuticals : Biochemistry and Biotechnology, Gari Walsh, 1998, John Wiley and Sons Limited.

## **4BT6.2: IMPACT OF SCIENCE & TECHNOLOGY ON SOCIETY**

### **UNIT-I**

Introduction of energy scenario, Conventional and non-conventional resources of energy, Utility and waste management of thermal and hydal energy, General idea of solar, wind, bio-mass, geothermal, tidal and wave energy, Sources and management of nuclear power energy, Electromagnetic energy, Ratio frequency and microwaves and its biological effects.

### **UNIT-II**

Global warming, Depletion of Ozone layer, Human activity and meterology, Animal and plant biodiversity. EI-Nino phenomenon and its effects, Solid waste, Waste disposal methods, Recycling of solid waste and its management.

### **UNIT-III**

Atmosphere-Introduction, Structure of the atmosphere, Chemical and Photochemical reactions, Primary air pollutants-sources, Control and harmful effects of Cox, NOx, SO, Hydrocarbons particulates, sampling techniques, Air pollution from automobiles, Photochemical smog, Acid rain, Case studies of air pollution.

### **UNIT-IV**

Hydrosphere . aquatic environment, Organic and inorganic water pollutants, Domestic and industrial waste water treatment, Aerobic and anaerobic treatment processes, Sampling and preservation, case studies of water pollution.

### **UNIT-V**

Lithosphere and noise pollution, Introduction of land and soil pollution, Treatment and disposal and harmful effects, General introduction of noise pollution and its effects. Sound unwanted from noise changes, Traffic noise, Prediction and control.

**Books Recommended :**

## **4BT6.3: WASTE MANAGEMENT**

### **UNIT-I**

Generation of Solid Wastes : Problems associated with Solid Waste Disposal, Goals and objectives of Solid Waste Management, Classification of Solid Waste. Solid Waste Generation, Factors Influencing Generation of Solid Waste, Characteristics of Solid Waste, Analysis of Solid Waste.

### **UNIT-II**

Onsite Handling, Storage and Processing : Public health and Aesthetics, onsite Handling, onsite Storage, Dust bins, Community Containers, Container Locations, Onsite Processing Methods.

### **UNIT-III**

Solid waste collections, transfer and transport : Collection Systems, equipment and labour requirement, collection routes, options for transfer and transport systems.

### **UNIT-IV**

Processing and disposal methods : Nature, Processing techniques and methods of disposal, sanitary land filling, composting and incineration, Bioremediation.

### **UNIT-V**

Recovery of resources, conversion products and energy : Material, recovery, energy generation and recovery operation, reuse in other industry.

### **Books Recommended :**

1. G. Tehobanogious, H. Theisen and R. Blassen - Solid Waste Engineering, Principles and Management Issues, Mc-Graw Hill Book Co. New Yorkq77.
2. C.L. Mantell Solid Waste Management, John Wiley, New York, 1975.
3. Bhide and Sundershen, %Solid Waste Management in Developing Countries+

### V-SEMESTER B.Tech. BIOTECHNOLOGY

S.NO	Code	Subject	L	T	Exam Hrs	MM Internal + End term
1	5BT.1	Bioenergetics . II	3		3	20+80
2	5BT.2	Recombinant DNA Technology	3		3	20+80
3	5BT.3	Object Oriented Programming using C++	3		3	20+80
4	5BT.4	Heat Transfer	3	1	3	20+80
5	5BT.5	Chemical Engineering Thermodynamics	3	1	3	20+80
6	5BT.6	Elective. II (Any one of the following	3		3	20+80
7	5BT.6.1	Plant Secondary Metabolites				
8	5BT.6.2	Production of Recombinant Molecules				
9	5BT.6.3	Industrial Mlicrobiology and Enzyme Technology				
		<b>Total</b>	<b>18</b>	<b>2</b>		<b>600</b>

## SemesterV (Practical Scheme)

S.NO	Code	Subject	P	Marks	
				Internal	End term
1	5BT.7	Bioenergetics . II	3	45	30
2	5BT.8	Recombinant DNA Technology	3	60	40
3	5BT.9	Object Oriented Programming using C++	3	45	30
4	5BT.10	Heat Transfer	3	60	40
5	5BT.11	Discipline and Extracurricular activity			50
	Total		12	210	190

### 5BT.1: Bioenergetics II

#### UNIT-I

**Bioenergetics:** first and second laws of thermodynamics and concept of free energy, high-energy phosphate compounds.

#### UNIT-II

**Carbohydrate metabolism :** Glycolysis, kreb's cycle. pentose phosphate pathway, glyoxylate cycle, glycogenolysis and glycogenesis, gluconeogenesis. Anaerobic respiration and basics of fermentation.

odd and even carbon saturated and Unsaturated Fatty acids, formation of ketone bodies, biosynthesis of triacylglycerols, membrane phospholipids, cholesterol and steroids.

#### **UNIT-IV**

**Protein metabolism** :metabolic fate of amino group,transamination and deamination, decarboxylation and oxidative degradation of amino acid,Nitrogen excretion and urea cycle.

#### **UNIT-V**

**Nucleic acid metabolism** :Biosynthesis and break down of purine & pyrimidine nucleotide by De novo and salvage pathway. Phosphorus and sulphur regulation. Metabolic regulation.

#### **Books Recommended :**

Principles of biochemistry :-Lehninger 3rd ed.McMilkan  
Biochemistry:-G.Zubay  
Biochemistry:-Stryer 5th ed.2001 W.H.Freeman  
Biochemistry:-Garret and Grasim Pub.Somders college

### **5BT.2: RECOMBINANT DNA TECHNOLOGY**

#### **UNIT-I**

Introduction to gene cloning, tools and enzymes used in gene manipulation:-Restriction enzymes DNA ligases DNA Polymerase Reverse Transcriptase Polynucleotide kinase,End labeling and other process used in rDNA technology.

#### **UNIT-II**

Major cloning vehicle and their application-Plasmid vectors, cosmid, Phagemid, phage vector, YAC,BAC,Ti plasmids,expression vector, shuttle vectors binary vectors, Transposons

#### **UNIT-III**

Making of genomic and cDNA libraries, their screening and major application,Blotting Techniques- Southern Blotting, Northern Blotting and Western Blotting..

#### **UNIT-IV**

Production of Recombinant Therapeutic Proteins, DNA Vaccines, Production of transgenic microbes and their application in Biotechnology,

and their application in Biotechnology. Production of transgenic Plants and their application in Biotechnology. Hazards of Recombinant DNA Technology.

### **BOOKS RECOMMENDED :-**

- Gene Cloning :-T.A. Brown 4th Ed Print 2001.
- Gene VII:- Benzamin Lewin Oxford University Press.1st Ed.Print 2003
- From genes to Clones:-Winacker 1st Ed. Print 2003. Panima Publishing Corp.
- From genes to Genomes:- Dale and Schantz Jhon.Wiley and Sons.Print 2002
- Gene manipulation :-Old and Primrose.Blackwell Science print 2001.
- Molecular Biotechnology:Glick and Pasternak ASM Press

### **5BT.3: OBJECT ORIENTED PROGRAMMING USING C++**

An overview of object Oriented Programming:Rationale for object programming,procedural vs.objected oriented approach;advantages of OOP; Characteristics of object oriented languages -objects, classes,inheritance, active data,message passing.

**UNIT-1** Object Oriented Programming Tools and C++:An overview of C++ programming,simple program construction,functions,statements, inputs/outputs. Variables and manipulators, data types. Library functions.

Functions :function declaration, calling, passing arguments to functions and returning values from functions,reference arguments,overloaded functions, variable and storage classes.

**UNIT-2** Objects and Classes :classes and objects, C++ objects and memory. Arrays:definition, multidimensional arrays, passing arrays to functions, arrays of structures.arrays as class members data,arrays of objects,arrays of strings.

**UNIT-3** Operator overloading: Overloading unary,binary and arithmetic operators,adding polar coordinates.concatening strings.multiple overloading,pitfalls of operator overloading and conversation.

**UNIT-4** Inheritance:derived class and base class, overriding memory functions, class hierarchy,public and private inheritance,multiple inheritance. Pointers:Addresses and pointers,pointer and arrays, pointer and functions use of pointers in strings, linked lists and memory management.

streams, strings and objects I/O, I/O with multiple  
printers. Applications: Object oriented programming in  
simulation and artificial intelligence, Programming environments.

## 5BT.4: HEAT TRANSFER

### UNIT-I

**Introduction** :-Basic concepts of heat and mass transfer, importance of heat and mass transfer in food processing .**Conduction** :Principles of conduction heat transfer fourier's law,derivation of general heat conduction equation incartsian and cylindrical coordinates, steady state heat transfer through slabs,plane walls,composite walls,cylinders,spheres etc. insulation and its purposes, critical thickness of insulation cylinder and sphers,general heat transfer equation for extended surfaces (Fins)

### UNIT-II

**Convection** :Natural and forced convection, nusselt number,dimensional analysis for free and forced convection dimensionless numbers used in convective heat transfer,important correlations for free and forced convection.

### UNIT-III

**Radiation** :Introduction,reflection,absorption and transmission of radiation,characterstics of black,grey and real bodies in relation to thermal radiation,Stefan Boltzman law; Kirchoff's law, Wein displacement laws, intensity of radiation, radiation between black bodies and diffused grey surfaces.

### UNIT-IV

**Heat Exchangers** :Classification,overall heat transfer coefficient, fouling factors, log-mean temperature difference for parallel and counter flow heat exchangers,heat transfer in shell and tube heat exchangers,effectiveness of parallel and counter flow heat exchanger by general and NTU (Number of Transfer Units) method, design of heat exchanger,applications of plate heat exchanger in HTST pasteurizer with regeneration.

### UNIT-V

#### **Evaporator:**

Types of evaporator-Natural circulation evaporators, Force circulation evaporator, falling film evaporators, climbing film evaporator, agitated thin-film evaporators and plate evaporators, principles of evaporation and evaporators



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### **BOOKS RECOMMENDED :**

- Heat transfer, Principles And Applications PHI New Delhi 2001 :Dutta B.K.
- Heat Transfer :-Rao.Y.V.C.

## **5BT.5: CHEMICAL ENGINEERING THERMODYNAMICS**

**UNIT-I** Review of First Law and Second Law of Thermodynamics. Volumetric Properties of Pure Fluids. PVT behavior of pure substances, Concepts of phase, Ideal gas equation of state, virial equation and its applications, cubic equations of state, generalized correlations for gases and liquids.

### **UNIT-II**

Heat Effects :Sensible heat effects, heat effects accompanying phase changes of pure substances, standard heats of reaction, formation and combustion, effect of temperature on the standard heat of reaction. Thermodynamic Properties of Fluids :Fundamental property relations, Maxwell's equations, Residual properties, Clapeyron's Equation, Generalized correlations for thermodynamic properties of gases.

### **UNIT-III**

Multicomponent Systems: Chemical potential, ideal-gas mixture, ideal solution, Raoult's Law. Partial properties, fugacity and fugacity coefficient, generalized correlation for the fugacity coefficient, excess Gibbs' energy, activity coefficient.

### **UNIT-IV**

Phase Equilibria at Low to Moderate Pressures: Phase rule, phase behavior for vapor liquid systems, Margules equation, Van Laar equation, Wilson equation, NRTL equation. Dew point, bubble point and flash calculations. Solution Thermodynamics: Ideal solution, fundamental residual-property relation, fundamental excess-property relation, Evaluation of partial properties. Heat effects of mixing processes. Partially miscible systems.

### **UNIT-V**

Chemical Reaction Equilibria. Reaction coordinate, equilibrium criteria to chemical reactions, standard Gibbs' energy change and the equilibrium constant. Effect of



equilibrium constant, evaluation of equilibrium  
equilibrium constants and compositions: gas-phase  
reactions, liquid-phase reactions. Calculation of equilibrium compositions for  
single-phase reactions. Multireaction equilibria.

### **Text/Reference Books**

1. Smith, J.M. Van Ness, H.C. and Abbott, M.M., "Introduction to Chemical Engineering Thermodynamics", 6th Ed., McGraw-Hill, 2001.
2. Rao, Y.V.C., "Chemical Engineering Thermodynamics", University Press, 1997.
- 3.

## **5BT6.1- PLANT SECONDARY METABOLITES**

### **UNIT-1**

Introduction, secondary plant products in nature and their occurrence, types and uses. Basic tools and techniques used in isolation and separation. Sources and types of antitumour compounds, food additives and insecticides

### **UNIT-2**

Production in vitro-optimization selection effect of metabolism on secondary metabolite-production, production under stress factors.

### **UNIT-3**

Production of alkaloids, steroids and saponins, Flavonoids. Mechanism and control by different factors, detoxification of secondary metabolites.

### **UNIT-4**

Production of Tannins, Glycosides, Resins. Microbial secondary metabolites, their occurrence types and uses.

### **UNIT 5**

Production of secondary metabolites by bioconversion genetic transformation for production of secondary metabolite Large scale production in bioreactor



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### **BOOKS RECOMMENDED:-**

Secondary Metabolites:-K.C.Ramawat.Oxford Press.Reprint 2000.

### **5BT6.2- PRODUCTION OF RECOMBINANT MOLECULES**

Requirement of recombinant molecules: in health, pharmaceutical, agriculture and industrial sectors, in search laboratories criteria of purity

1. Rationale for the design of vectors for the over expression of recombinant proteins: selection of suitable promoter sequences, ribosome binding sites, transcription terminator, fusion protein tags, purification tags, protease cleavage sites and enzymes,
2. Plasmid copy number, inducible expression system, Methods of DNA Transfection in Mammalian Cell lines
3. Over expression conditions, production of inclusion bodies, solubilization of insoluble proteins, purification protocols and upscaling
4. Determination of purity and activity of over expressed protein
5. Experiments using model systems: E. coli, Yeast, Baculovirus, Agrobacterium tumifience

### **BOOKS RECOMMENDED :-**

1. Gene Manipulation:-Old and Primrose. Blackwell Science. Print 2001
2. Protein Engineering :-Lilia Alberghina.Harvard Academy 2003
3. Pharmaceutical Biotechnology :-Vyas and Dixit CBS Publications 1999
4. Recombinant DNA :-Watson and Gillman Scientific Book 2nd Ed. 2001
5. Molecular biotechnology :-Glick & Pasternak.ASM Press



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### **5BT6.3- INDUSTRIAL MICROBIOLOGY AND ENZYME TECHNOLOGY**

1. Introduction, Classification of Microbial products. Microbial Processes for Production of organic acids, solvents, antibiotics, enzymes,
2. Production of polysaccharides, lipids, pigments and Microbial Biotransformation.
3. Strain Improvement of industrially important Microorganisms, Equipments and Accessories for industrial processes. STR and Airlift fermenters, Bioreactors used for solid substrate fermentation.
4. Enzymes: Methods of Separation,. Enzyme Immobilization Technology, Protein Engineering.
5. Application of enzymes in industry, analytical purpose and medical therapy.

#### **BOOKS RECOMMENDED :-**

1. Industrial microbiology:-Casida Newage Publication 2001
2. Industrial microbiology:-Prescott and Dunn CBS Publications 4th Ed. 1999
3. Enzymes:-Trevor.Horwood 2001
4. Journals and Reviews

## B.E. BIOTECHNOLOGY

S.NO	Code	Subject	L	T	Exam Hrs	MM Internal + End term
1	6BT.1	Genome Analysis	3		3	20+80
2	6BT.2	Biostatistics	3		3	20+80
3	6BT.3	Fermentation technology & Downstream processing	3		3	20+80
4	6BT.4	Food Biotechnology	3	1	3	20+80
5	6BT.5	Mass Transfer	3	1	3	20+80
6	6BT6	<b>Elective (Any one of the following):-</b>				20+80
	6BT6.1	Neuroscience	3		3	
	6BT6.2	Professional communication skills				
	6BT6.3	Biomonitoring				
		<b>Total</b>	<b>18</b>	<b>02</b>		<b>600</b>

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S.NO	Code	Subject	P	Marks	
				Internal	End term
1	6BT.7	Biostatistics	3	60	40
2	6BT.8	Fermentation technology & Downstream processing	3	60	40
3	6BT.9	Mass Transfer	3	60	40
4	6BT.10	Instrumentation & Process Control	2	30	20
5	6BT.11	Discipline and Extracurricular activity			50
	Total		11	210	190

### 6BT.1 -GENOME ANALYSIS

**UNIT-1.** Basic structure of prokaryotic and eukaryotic genome. Human genome project and its application to future of mankind.

**UNIT-2.** Chromation model, concept of gene, linkage and crossing over, linkage analysis in drosophila and neurospora.

**UNIT-3.** Pedigree analysis in human. Genetic mapping and its tools, genetic mapping of complex character.

**UNIT-4.** Multigene families in human genome and repetitive DNA, C-Value paradox and complexity of genome, Gene Interaction.

**UNIT-5** Physical mapping of genome-chromosome walking, chromosome painting, FISH, GISH, zoo biot. Dot blot, VNTR, RFLP, RAPD, RACE, SNPs, QTLs, EST, CpG island indentification. exon trapping and sequence analysis.

#### BOOKS RECOMMENDED

1. Genetics :-Griffith and Suzuki
2. Principles of Genetics:-Gardner 8th Ed. Pring,2002,Jho
3. Genes VIII :-Benzamin Lewin 1st Ed.2003,Oxford University

## OB 1.2- BIOSTATISTICS

### UNIT

- 1 Introduction, Definition and functions of Biostatistics. Data collection and presentation; Probability-Mathematical, Statistical and Axiomatic definitions, Addition and Multiplication Theorems; Probability Distribution Functions- Binomial, Poisson and Normal.
2. Descriptive statistic; Measure of central tendency-Mean, Mode and Median; Measures of Dispersion-Range, Quartile Deviation, Standard Deviation, Coefficient of variation; Relationship between location and scale parameters.
- 3 Inferential statistic; Confidence interval of the means: test of significance-hypothesis, one and two tail tests. Errors of the first and second order; student statistics-test of hypothesis that population means equals postulated mean, Equality of two population means.
4. Analysis of variance; one way classification - Completely Randomized Design with equal and unequal sample sizes; two way classification Randomized block design (one observation per cell ; Multiple Comparisons Chi-square Tests.
- 5 .Relationship between variables; Correlation analysis-scatter diagrams, correlation coefficient, coefficient of determination; Regression analysis-least square method, best fit lines, regression equation.

### BOOKS RECOMMENDED :-

1. Statistics Concept and application:-H. Frank and S.C. Althoen. Cambridge University Press
2. Statistical Methods :-G.W. Snedecor and W.G. Cochran
3. Basic Statistics :-B.L. Agarwal
4. Principles and Procedure of Statistics:-A Biometrical Approach :-R.G.D. Steel and J.H. Torrie

### UNIT I

1. An introduction fermentation technology-basic microbial growth kinetics, Isolation, preservation and improvement of industrially important microorganism.
2. Media for industrial fermentation, Various C , N minerals Vitamins and complex nutrients, Sterilization process, development of inocula for Industrial fermentations.
3. Designing of a fermentor, operation and application. Instrumentation and Control, fermentation kinetics, optimization of fermentation process by Quantitative analysis. Aeration and agitation.
4. Downstream processing Recovery and purification of fermentation products:- Centrifugation, Sedimentation. Filtration, Micro filtration, ultra filtration solvent extraction, Reverse osmosis adsorption-desorption process. Salt precipitation,
5. Membrane based separation process:-, Pervaporation, membrane modules, concentration polarization. Membrane characterization. Effluent treatment Methods.

### BOOKS RECOMMENDED :-

1. Principles of fermentation technology :-Stanbury, Whittaker and Hall, 2nd Ed. 1997. Aditya Books.
2. Fermentation Microbiology and Biotechnology :-El-Mansi and Bryce, 2002
3. Process Biotechnology Fundamental :-Mukhopadhaya
4. Biochemical Engineering and Biotechnology :-Atkinson B and Mavituna F.

## 6BT.4 - FOOD BIOTECHNOLOGY

### UNIT

1. Micro-organisms associated with food, factors affecting growth of micro-organisms in food, food spoilage.
2. Fermented Foods-Fermentation processes for manufacture of fermented food and food products-alcoholic beverages and other products, fermented milk products, pickles.
3. Protein foods and nutraceuticals: SCP, mushroom, food yeasts, algal proteins nutraceuticals from plant parts (flavonoids, carotenoids, phytosterol) and their applications, curative foods and transgenic plant foods. Bioprotection and biopreservation.
4. Enzymes in food: Mechanisms of enzyme functions and reactions in process techniques-starch and sugar conversion process, banking by amylases, deoxygenation and desugaring by glucose oxidase, cheese making by proteases. Beer mashing and chill proofing.

of whey, molasses, starch substrates and other food

### Books Recommended:

## 6BT.5- MASS TRANSFER

### UNITs

1. Introduction: Molecular diffusion in fluids, diffusivity and mass transfer Coefficient  
intaphase mass transfer.
2. Mass transfer Equipments, gas Absorption, countercurrent multistage operation, plate  
column and packed
3. Distillation. vapour liquid Equilibria, flash vaporisation, differential  
distillation, continous rectification, McCabe Thiele method, bubble cap distillation column.
4. Liquid liquid equilibria, liquid extractio, liquid solid equilibria. leaching  
humidification, wet and dry bulb temperatures. psychrometric charts. dehumidification and  
cooling towers.
5. Drying and equilibrium drying operations, crystalization, adsorption and ion exchange.

### Books Recommended :

#### Title

1. Mass Transfer Operation
2. Units Operations of chemical engineering

#### Author

Treble. Robert E  
McCabe. Smith

## 6BT6.1- Neuroscience

### UNIT

1. Cytology of neuron, properties of neuron resting membrane potential Functional  
consequences of passive membrane,
2. Voltage gated channels and generations of action potential



3. Principles underlying electrical and chemical synaptic transmission Factor controlling transmitter release morphology of chemical synapse and pattern of inter connections
  4. Chemical messengers and small molecules and peptides Gaseous signals and response of brain, molecular steps in synaptic transmission
  5. Molecular aspect of postsynaptic receptor, NMDA receptors, long term potentiation Molecular biology of learning Reaction of neuron to injury
- 1.

## 6BT6.2- PROFESSIONAL COMMUNICATION SKILLS

### UNIT

1. Communication: Definition, Barriers in communications, implication of Communication, Purpose of communication. Elements: Preparation, structure and personal interaction
2. Oral Communication; Skill and Techniques of Speaking preparation of Speaking, Development of speaking skills, barriers to speaking, speaking structure, bridging points, time limitation/Length of speech, Use of Humor.
3. Visual Communication: Nature and scope of visual aids, Bolds, slides, overhead projector, cutouts. Technical letter writing: Purpose of writing, space/layout, economy of words, use of verb/passive voice, typeface (italics, bold, underline) and use of Verb/passive voice, typeface (italics, bold, underline) and use of intonation.
4. Report writing :Preparation, report structure (purpose of report, scope, shape presentation of report, introduction or report, bridging of report, style of report, and index of report.
5. Public communication: meetings, planning and discussion, opening procedure, timing degree of formality, behavior, repetitive, interviews (complexity of situation, preparation of thinking, preparation of setting, opening of the interview, style of interview)

**Note :** Group discussion may be introduced to enhance oral communication and debates, speeches; addresses may be introduced for Public.

### **3- BIOMONITORING**

#### **UNIT**

1. Definition strategies and principles of Biomonitoring, contaminants and toxicants in the environments.
2. Bioassays -Introduction, toxicity testing, use in environment management.
3. Cytotoxic and genotoxic assays- Biochemical basis of toxicity, detection of mutagens and carcinogens.
4. Bioindicators-Introduction,use in environment management.
5. Molecular and cellular approaches for biomonitoring-principles and applications;biosensors.

## B.E. BIOTECHNOLOGY

S.NO	Code	Subject	L	T	Exam Hrs	MM Internal + End term
1	7BT.1	Environmental Biotechnology	3		3	20+80
2	7BT.2	Database Management System	3		3	20+80
3	7BT.3	Bioinformatics	3	1	3	20+80
4	7BT.4	Molecular Diagnostic Techniques	3		3	20+80
5	7BT.5	Transport Phenomena	3	1	3	20+80
6	7BT.6	<b>Elective (Any one of the following):-</b>	3		3	20+80
	7BT.6.1	Marketing Management				
	7BT.6.2	Bioreactor Design and Analysis				
	7BT.6.3	Computer Networking				
		<b>Total</b>	<b>18</b>	<b>2</b>		<b>600</b>

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S.NO	Code	Subject	S	P	Marks	
					Internal	End term
1	7BT.7	Environmental Biotechnology		3	60	40
2	7BT.8	Database Management System		3	60	40
3	7BT.9	<b>Practical Training &amp; Seminar</b>		3	60	40
4	7BT.10	Intellectual Property Right		2	30	20
5	7BT.11	<b>Discipline and Extracurricular activity</b>				50
	Total			11	210	190

### 7BT.1- ENVIRONMENTAL BIOTECHNOLOGY

#### UNIT-I

##### **Role of Biotechnology in Environment Protection :**

Environmental Biotechnology, Current Status of Biotechnology in Environment Protection, Future .Microbiology and Biochemistry of Waste Water Treatment :Biological Treatment,Impact of Pollutants on Biotreatment, Cell Physiology and Important Microorganisms, Plasmid Borne Metabolic Activities, Bioaugmentation, Packaged Microorganisms, Use of Genetically Engineered Organisms.

#### UNIT-II

##### **Bioreactors for Waste Water Treatment :**

Biological Processes for Industrial Effluent Treatment, Aerobic Biological Treatment, Anaerobic Biological Treatment,Periodic Biological Reactors, Membrane Bioreactors,Use of Immobilized Enzymes and Microbial Cells .

ts :

Sources of Heavy Metal Pollution, Microbial Systems for Heavy Metal Accumulation, Biosorption, Bioleaching. Bioremediation : What is Bioremediation? Case Histories, Constraints and Priorities of Bioremediation, Bioaugmentation for Bioremediation, Bioreactors for Remediation Processes, Types of Bioremediation, Applications - Examples, Biotechnology and Oil Spills .

#### UNIT-IV

##### **Biotechnology for Hazardous Waste Management :**

Xenobiotic Compounds, Recalcitrance, Hazardous Wastes, Biodegradation of Xenobiotics, Biological Detoxification, Biotechnology Applications to Hazardous Waste Management, Examples of Biotechnological Applications to Hazardous Waste Management.

#### UNIT-V

##### **Biotechnology for Waste Treatment of Food and Allied Industries :**

Biological Treatment Methods, SCP and Biomass from Waste, Distillery Industry. Novel Methods for Pollution Control : Vermitechnology, Waste Water Treatment Using Aquatic Plants, Root Zone Treatment. Aiming for Biodegradable and Ecofriendly Products .

#### **Text Books:**

1. Waste water Engineering Treatment and Disposal and Reuse" by Metcalf & Eddy.
2. "Water Pollution Management Hand Book" by Lepathak.
3. "Waste Water Management" by Arceivala.
4. "Environmental Biotechnology" by C. F. Forster and D. A. J. Wase.
5. "New Processes of Waste water treatment and recovery" by G. Mattock (ED) Ellis Horwood.
6. "Biochemical Engineering fundamentals" 2nd ed. by J E Bailey and D F Ollis , McGraw - Hill (1986). Chapters 13 & 14.
7. "Environmental Biotechnology" by Jogdand.

#### **7BT.2- DATA BASE MANAGEMENT SYSTEM**

##### **UNIT – I**

Basic Concepts and Conceptual Database Design Database administrator & Database Users, Characteristics of the Database, Database Systems, Concepts and Architecture, Data Models, Schemes & Instances, DBMS Architecture & Data Independence, Database Languages & Interfaces, Overview of Hierarchical, Network & Relational Data Base Management Systems, Data Modelling Using The Entity-Relationship Model ó

os, Cardinality of Relationships, Strong and Weak  
ization, and Aggregation, Translating your ER Model

## UNIT – II

Relational Model, Languages & Systems: Relational Data Model & Relational Algebra, Relational Model Concepts, Relational Model Constraints, Relational Algebra, SQL ó A Relational Database Language, Data Definition in SQL, View and Queries in SQL, Specifying Constraints and Indexes in SQL, Practicing SQL commands using ORACLE.

## UNIT – III

Relational Data Base Design and Oracle Architecture: Functional Dependencies & Normalization for Relational Databases, Functional Dependencies, Normal Forms Based on Primary Keys, (1NF, 2NF, 3NF & BCNF), Lossless Join and Dependency Preserving Decomposition, Oracle 8 Architecture, Database Storage, Oracle Software Structures, Shared Database Access Mechanism, Database Protection.

## UNIT – IV

Transaction Management: Transaction Concept and State, Implementation of Atomicity and Durability, Concurrent Executions, Serializability, Recoverability, Implementation of Isolation, Concurrency Control Techniques, Lock-Based Protocols, Timestamp-based Protocols, Validation ó based Protocols, Multiple Granularity, Multiversion Schemes,

## UNIT-V

**Deadlock :** Deadlock Handling, Recovery System, Failure Classification, Storage Structure, Recovery and Atomicity, Log-based Recovery, Shadow Paging, Recovery with Concurrent Transactions, Buffer Management, Failure with Loss of Nonvolatile Storage, Advanced Recovery Techniques, Remote Backup Systems. Indexing, Hashing and Query Processing: Query Processing, Overview, Measures of Query Cost, Selection Operation, Sorting, Join Operation, Other Operations, Evaluation of Expressions, Concepts of Object Oriented

Database Management Systems, Distributed Data Base Management Systems.

## TEXT:

1.Korth, Silberschatz, "Database System Concepts", 4thEd., TMH, 2000.2. Steve Bobrowski, "Oracle 8 Architecture", TMH, 2000

## REFERENCES:

1Date C. J., "An Introduction to Database Systems", 7thEd., Narosa Publishing, 2004  
.2Elmsari and Navathe, "Fundamentals of Database Systmes", 4thEd., A. Wesley, 2004  
3Ullman J. D., "Principles of Database Systems", 2ndEd., Galgotia Publications, 1999.

## 7BT.3 : BIOINFORMATICS

**Unit I:- The Internet and Biologist:** Internet basics, FTP, World wide web, Introduction to Primary & Secondary databse, GenBank, GCG, ACDEB. Structure Databases: Introduction to structures, PDB, MMDB, Structure file formats, Visualizing structural

**Unit II:- Information Retrieval from Biological Databases & submission of DNA Sequences to the Databases:** Retrieving database entries, Integrated information retrieval: The entrez system, sequence databases beyond NCBI, Medical Databases; Where to submit nucleotide sequences, How to submit on the world wide web, How to submit with sequin, Molecular modelling.

**Unit III:- Sequence Alignment and Database Searching:** Introduction, Evolutionary basis of sequence alignment, Optimal alignment methods, Substitution scores & gap penalties, Statistical significance of alignments, Database similarity searching, FASTA, BLAST, Low complexity regions, Repetitive elements

**Unit IV:- Multiple Sequence Alignment & Genome Mapping:** Progressive alignment methods, Motifs and patterns, Probe, Presentation methods, Abscript; Different types of maps: physical, genetical, etc. Synteny, Human genome project, Application of genome mapping, Chromosome maps.

**Unit V:- Predictive Methods Using Nucleotide & protein Sequences:** Framework, marking repetitive DNA, Database search, Codon bias detection, Detecting function sites in the DM, Protein identity based on composition, Physical properties based on sequences, secondary structure and folding Classes, Drug designing.

#### **Reference:**

1. Bioinformatics: A practical guide to the analysis of genes and proteins A.D. Baxevanis and B.F.F. Ouellette (Eds). 2002 John Wiley and Sons.
2. Bioinformatics: Sequence and Genome Analysis by D.W. Mount, 2001, Cold Spring Harbor Laboratory Press.

### **7BT.4 : Molecular Diagnostic Techniques**

**Unit I:-** Basic tools used in DNA library screening, DNA selection, reporter genes, Biosensors.

**Unit II:-** DNA Microarray and its application, Monoclonal Antibodies and their Various uses.

**Unit III:-** PCR its Types and its application as a diagnostic tool in plant animals and microbes. Molecular pathology: screening mutation in DNA and chromosomal disorder.

man disease óAlzheimer's disease, cancer, diabetes,  
multiple sclerosis, obesity, schizophrenia.

**Unit V:-** Use of genetic markers and gene technology in forensic science and personal identification, biomedical research, toxicology, drug delivery vehicle and target drug designing, bioremediation, infectious agent monitoring. Quality control in food industry, animal husbandry and agriculture.

Books recommended:

1. Human molecular biology-Reed
2. Gene manipulation- Old and Primrose
3. Molecular biology and biotechnology=Walker and Rapley

### **7BT.5 Transport Phenomena**

**Unit I:-**Introduction, various transport processes, unsteady viscous flow, heat conduction, and diffusion, momentum, energy and mass transport in boundary layer with relevant analogies. Transport by molecular motion Newton's law of viscosity, Fourier's law of heat conduction and Fick's law of diffusion

**Unit II:-** Transport in laminar flow or in solids in one dimension: development of continuity (conservation) equation. Velocity, temperature and concentration profile . Momentum, energy and mass flux

**Unit III :- Transport in arbitrary continuum :** Stream function, rotational and irrotational flow, vorticity, equation of change for isothermal, on isothermal, and multicomponent system. Navier-stokes equation. Euler equation, equation of energy, equation of motion for free and forced convection(heat/mass)

**Unit IV:-Transport in turbulent flow:** Time smoothing of equation of change, eddy viscosity, eddy thermal conductivity, eddy diffusivity, velocity and temperature and concentration profile

**Unit V:-Interphase momentum, heat and mass transfer:** Concept and **relation** of friction factor, heat transfer coefficient mass transfer coefficient, dimensionless coefficient

Books recommended

Chemical engineering III By Coulson and Richardson

### **7BT6.1- Marketing management**

**Unit I:-**Marketing Concepts - Approaches to Marketing - Study Approaches and Functional Approaches - Marketing Process - Functions of Marketing



ature, Process and Contents of Marketing Plan - The  
Analyzing needs and trends in Macro Environment,  
Economic Environment, Technical Environment, Political Environment and Socio-  
cultural Environment

**Unit III:-**Sales Forecasting - Methods - Market Research - Scope, Obstacles in  
acceptance.Consumer Behaviour - Factors influencing buyer behaviour - Buyer decision  
process - Consumer Psychology - Industrial Buyer behaviour Vs. Domestic Buyer  
behaviour - Customer satisfactions Vs. Customer delight - Consumer value and  
satisfaction

**Unit IV:-**Dealing with competition - Identification and Analysis of Competitors  
Market segmentation - Bases for market segmentation of consumer goods, industrial  
goods and services - Market Targeting and positioning strategies .

**Unit V:-** Market Evaluation and Controls - Types, process, obstacles to marketing  
control - Marketing Audit - Marketing Ethics.

### **Books Recommended**

1. Marketing Management - Philip Kotler
2. Fundamentals of Marketing – Stanton
3. Marketing Management - V.S.Ramaswamy and S.Namakumari
4. Marketing Management - Saxena

## **7BT6.2- BIO- REACTOR DESIGN &ANALYSIS**

**Unit I-** Types of reactors ó bath, plug flow reactor (PFR), continuous stirred tank reactors (CSTR), fluidized bed reactor bubble column, air lift fermentor etc. concept of ideal and non-ideal reactor.

**Unit II-** Residence time distribution, models of non-ideal reactor-plug flow reactor for microbial processes, optimization of reactor systems. Multiphase bioreactors ópacked bed with immobilized enzymes and or microbial cells. Three phase fluidized bed tricking bed reactor, Design and analysis of above reactor systems.

**Unit III-** Gas liquid reactors, unconventional bioreactors like Hollow fiber reactor, membrane reactor, perfusion reactor for animal and plant cell culture. Reactor stability.

**Unit IV-** Thermodynamic and stoichiometric aspects of microbial processes, engineering analysis of metabolic pathways, optimization of fermentation media, kinetic modeling of enzyme and microbial processes, mass transfer in bio-chemical processes, scales up concept, batch fed batch and continuous microbial reactors.

**Unit V-** Immobilized enzymes/cell reactors. Non ideal effects. Sensors for monitoring bioprocess parameters. Bioprocess control and computer coupled bioreactors. Growth and production formation by recombinant cells.



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## BT-706.3 COMPUTER NETWORKING

### Unit 1

COMPUTER NETWORKS AND THE INTERNET: What is Internet networking protocols, Network Edge, Access Networks and Physical Media. Protocol Layers and their service models. Internet Backbones, NAPs and ISPs.

### Unit 2

APPLICATION LAYER: Protocols and Services provided by Application Layer, Transport protocols. The word wide web- HTTP, message formats, User server Interaction, and web caches, FTP commands and replies. Electronic mail, SMTP, mail message Formats and MIME and Mail Access protocols, DNS-The Internet's Directory Service, DNS records and Messages.

### Unit 3

TRANSPORT LAYER: Transport-layer service and principles, Multiplexing and Demultiplexing applications, connectionless, Transport-UDP segment structure and UDP checksum. Principles of Reliable Data Transfer- Go back to N and selective Repeat. Connection oriented Transfer- TCP connection and segment structure, sequence oriented and acknowledgement numbers, Telnet, Round trip time and timeout. TCP connection management.

### Unit 4

NETWORK LAYER AND ROUTING: Network service Modle. Routing principles, link state routing Algorithm. A distant vector counting & OSPF algorithms. Router components, Input port, switching fabric and output port. IPV6 packet Format.

### Unit 5.

POINT-TO-POINT PROTOCOL (PPP): Transition states, PPP.layers- physical layer and Data Link Layer. Link control protocols-LCP packets and options. Authentication PAP and CHAP. Network control protocol(NCP). SONET/ SDH: Synchronous Transport signals. Physical configuration-SONET Devices, selections, Lines and paths. SONET Layer-Photonic Layer. Section Layer, Line Layer, Path Layer and Device-Layer Relationship, SONET Frame ó frame format.

#### Recommended books:

1. J.F. Kurose and K.W. Ross- Computer Networking, peare Education Asia.
2. B.A. Forouzan-Data communications and Networking, Tata Mo-Gran Hill.
3. Garcia and widjaja-Communication Networks, Tata Mo-Gran



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## Semester VIII

- The candidate will be required to undertake a project work of 4-5 months on a relevant topic in a reputed Industry /R&D center/ Institute, and submit a scientific report of the work done in the project under the guidance of supervisor(s) at work place.
- **Evaluation of project work**

	<b>Maximum Marks</b>		
	<b>Internal</b>	<b>External</b>	<b>Total</b>
<b>Project work (at Industry/ Organisation)</b>	<b>480</b>	<b>320</b>	<b>800</b>
<b>Seminar</b>	<b>120</b>	<b>80</b>	<b>200</b>
<b>Total</b>			<b>1000</b>

## **B. Tech. Biotechnology, III Sem.**

### List of Practicals

#### Microbiology

3BT.7

1. Safety precautions in the laboratory, care and use of light microscope, principle and use of autoclave and hot air oven.
2. Different culture media and their constituents. Preparation of broth and solid culture media.
3. Isolation of discrete colonies from mixed culture.
4. Isolation of pure culture: streak plate, spread plate and pour plate.
5. Preparation of agar slants and streaking, Cultural characteristics of micro-organisms.
  
6. Simple and Gram staining technique.
7. Spore staining.
8. Negative staining
9. Isolation of mutants by antibiotic sensitivity test
  
13. Physical factors affecting growth of microbes.
  - Temperature
  - Ph
  - Effect of UV exposure on microbial growth
  
14. Methylene Blue Reductase test in milk
15. Litmus milk reactions

(Indole, Methyl Red, Voges Proskauer &

17. Cultivation of molds and their identification.

### Cell BIOLOGY

3BT.8

1. Use of a compound microscope
2. Histochemical localization of Starch, Cellulose, Proteins and Polysaccharides in the cells/ tissues.
3. Squash preparation of onion root tips to study different stages of Mitosis.
4. Smear preparation of the anthers to study different stages of Meiosis.
5. Measurement of size of various types of cells using ocular and Stage micrometer.
6. Counting of Spores present in the spore suspension using haemocytometer.
7. Preparation of leaf extract and separation of leaf pigments using radial / paper chromatography.
8. Differentiation of various leukocytes of blood smear, using leishmn stain.

### Unit Operation

3BT.9

1. Experimental verification of Bernoulli's equation and plotting of graph of energy Vs distance
2. Determination of coefficient of discharge in venturimeter.
3. Calibration and measurement of the discharge through the rotameter.
4. Determination of Reynold,<sup>s</sup> number for laminar and turbulent flow and study of transition zone.
5. Determination of coefficient of discharge of a Orificemeter.
6. Experimental verification of Ergun's equation and plotting of Reynold's number Vs friction factor for a packed bed column.
7. Determination of losses of head in pipe fittings at the various water flow rates.

of Darcy's law and find out the coefficient of permeability in a medium.

9. Calculation of Critical speed of Ball mill and surface area of the given sample.
10. Determination of terminal velocity and collective efficiency for cyclone separation operation.
11. Sieve analysis of the given sample for its particle size distribution by sieve shaker.
12. Calculation of crushing law's constant by Jaw crusher.

B. Tech. Biotechnology, IV sem.

List of Practicalø

4BT.7

Molecular Genetics

1. Isolation of genomic DNA from bacteria.
2. Isolation of genomic DNA from fungi
3. Testing of isolated DNA by Agarose gel electrophoresis.
4. Determination of purity of DNA (spectrophotometrically).
5. Determination of  $A_{260}$  values of DNA.
6. Quantitative estimation of DNA.
7. Determination of photo repair of mutant bacterial stain.
8. Determination of dark repair of mutant (Bacterial) stain.
9. Separation of proteins by ion- exchange chromatography.
10. Separation of proteins by SDS-PAGE.

4BT.8

Analytical Techniques in Biotechnology

1. Preparation of buffer and determination of buffering capacity.
2. Determination and study of titration curve of amino acids (Alanine).
3. Titration of lipid sample [oil, butter] using phenolphthalein.
4. Determination of  $pK_a$  of bromophenol blue.

of Methylene blue.

known concentration of bromophenol

blue/methylene blue.

7. Preparation of standard curve of protein (BSA) and estimation of the amount present in a sample.
8. Gel permeation chromatography
9. Calculation of R<sub>f</sub> value of the unknown sample after chromatogram.
10. Thin layer chromatography (TLC) using Silica Gel G<sup>+</sup> and calculation of the R<sub>f</sub> value of unknown samples.

4BT.9

### Developmental Biology

1. Lab working method, equipments etc. and part of compound  
Microscope
2. Structure of monocot and dicot seeds.
3. Demonstration of germination of monocot and dicot seeds.
4. Various kinds of tissues present in roots, stem and leaves and their arrangement.
5. Morphology of flowering plants and structure of general angiosperm plant.
6. Reproductive organs of the angiosperm flower.
7. Different stages of Mitotic & Meiotic cell division.
8. Developmental stages of Hydra.
9. Life cycle of Drosophila.
10. Polytene chromosomes of Drosophila.
11. Embryological development stages of frog.
12. Developmental stages of chick embryo (permanent slides).



### A. Qualitative Tests for biomolecules

1. Preparation of buffers of various ranges.
2. Preparation of solutions of various molarities and normalities.
3. Tests for the detection of carbohydrates (Molish and An throne) Proteins (Biurette, Ninhydrin and Sakaguchi) and Lipids (Solubility in polar and non polar Solvents, Emulsification test and salkowski tests)
4. Distinction between Reducing and Non ó reducing sugars using Fehling<sup>o</sup>s and Benedic<sup>t</sup>'s test.
5. Distinction between monosaccharideø, disaccharides and polysaccharides using Barfoed's test and Iodine test.
6. Distinction between aldose and ketose sugar using Seliwanoff's test and Inversion test.

### B. Quantitative estimations for biomolecules

7. Estimation of Total carbohydrate by Anthrone method
8. Estimation of Reducing sugars by DNSA method
9. Estimation of Proteins by Biurette method
10. Estimation of Amino acids by Ninhydrin method
11. Estimation of RNA by Orcinol method
12. Estimation of DNA by Diphenylamine method

## **B. Tech. Biotechnology, V sem. List of Practical's**

### **5BT.7**

### **Bioenergetics II**

1. Determination of acids value of fat.
2. Determination of saponification value of fat.
3. Estimation of vitamin <sup>o</sup>C<sup>o</sup> by DCPIP method.
4. Estimation of B-Carotene.
5. Estimation of catalase activity.

activity.

ation of amino acids by paper

chromatography.

8. Separation and identification of Photosynthetic Pigments by paper chromatography.

## 5BT.8 RECOMBINANT DNA TECHNOLOGY

1. Electrophoresis of DNA.
2. Isolation of RNA.
3. Isolation of Plasmid.
4. Restriction Digestion.
5. To Prepare absorption Spectra of nuclei acid.
6. To determine the purity of nucleic acid.
7. Quantification of DNA by DPA method.
8. Quantification of RNA by orcinol method.
9. Determination of  $T_m$  value.
10. PCR Analysis.

## 5BT.9 OOP LAB

1. WAP to Find factorial of a given number.
2. WAP a program to find avg. of n numbers.
3. WAP a Program to find Largest among three numbers.
4. WAP a Program to find maximum and minimum value from a given list.
5. WAP to Search an element in the given list.
6. WAP to find factorial of given number using function.
7. WAP to Process shopping list using classes.
8. WAP to overload unary operator++.
9. WAP to overload binary operator +
10. WAP for string concatenation by overloading + operator.

ay total marks of students assuming that test  
ed in three different classes.

- 12.WAP to show run time polymorphism using virtual function.
- 13.WAP to show use of virtual base class.

### **5BT.10 HEAT TRANSFER LAB**

1. Study of conduction heat transfer through insulating powder.
2. Study of conduction heat transfer in composite wall.
3. Study of radiation heat transfer by black body.
4. Study of convection heat transfer in natural convection.
5. Study of the temperature distribution along the length of a pin.
6. Study of the temperature distribution along the length of a pin  
Fin under free and forced convection heat transfer.
7. To study the heat transfer in shell and tube heat exchanger
8. To study unsteady state heat transfer by the lumped capacitance
9. Study of heat transfer in agitated vessel
- 10.To concentrate a 5% (wt) sodium carbonate solution to about 15%  
(wt) solution.

### **B. Tech. Biotechnology, VI sem. List of Practicals**

#### **6BT.8 FERMENTATION TECHNOLOGY & DSP**

1. Demonstration of oxidative and fermentative utilization of  
carbohydrate.
2. Use of alginate for cell immobilization.
3. Microbial production of antibiotics.
4. Microbial production of enzymes.
5. Microbial production of ethanol.
6. Determination of thermal death point.
7. Determination of thermal death temperature.
8. Qualitative tests for and products of fermentation.
9. Estimation of microbial biomass during fermentation.

factors on the end product formation by

## 6BT.9 MASS TRANSFER

1. To determine diffusion coefficient of liquid vapor in air.
2. To verify Rayleigh's Eq<sup>o</sup> for differential distillation of binary system.
3. To find out crystal yield with and without seeds.
4. To study the drying characteristic of a wet granular material in a tray dryer.
5. To investigate the mass transfer characteristic of a wetted wall column.
6. Liquid - Liquid extraction in a packed column for co current and counter current flow of binary systems.
7. To study the absorption of a gas in a packed column and calculation of NTU and HTU.
8. Studies on solid-liquid extraction column.
9. Studies on the sieve plate distillation unit.

## 7BT.7 ENVIRONMENTAL BIOTECHNOLOGY EXPERIMENTS

1. Determination of pH of water samples.
2. Determination of pH soil samples.
3. Determination of ammonification and nitrification in soil.
4. Determination of portability of water by MPN.
5. Determination of coliform bacteria in water samples.
6. Determination of O<sub>2</sub> content.
7. Determination of BOD.
8. Determination of COD.
9. Determination of chloride contents of water sample.