

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY
ANANTAPUR**

B.TECH. BIO-TECHNOLOGY

**III YEAR I SEMESTER
COURSE STRUCTURE**

CODE	SUBJECT	T	P	C
	Transport Phenomena in Bio Processes	4+1*	-	4
	Biochemical Reaction Engineering - I	4+1*	-	4
	Basic Industrial and Environmental Biotechnology	4+1*	-	4
	Genetic Engineering	4+1*	-	4
	Plant Biotechnology	4 +1*	-	4
	Managerial Economics and Financial Analysis	4 +1*	-	4
	Molecular Biology and Genetic Engineering Lab	-	3	2
	Advanced English Communication Skills Lab	-	3	2
	TOTAL	30	6	28

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B.TECH. BIO-TECHNOLOGY

**IV YEAR I SEMESTER
COURSE STRUCTURE**

CODE	SUBJECT	T	P	C
	Bioinformatics	4+1*	-	4
	Bio Ethics, Bio Safety And Intellectual Property Rights	4+1*	-	4
	Downstream Processing	4 +1*	-	4
	Biosensors and Bioelectronics	4+1*	-	4
	ELECTIVE –I	4 +1*	-	4
	Biomaterials Science and Technology			
	Cell Signaling			
	Structural Biology			
	Cancer Biology			
	ELECTIVE –II	4 +1*	-	4
	Creativity Innovation and Product Development			
	Nano Biotechnology			
	Metabolic Engineering			
	Bioinformatics Lab	-	3	2
	Downstream Processing Lab	-	3	2
	TOTAL	30	6	28

NOTE: All University Examinations (Theory and Practical) are of 3 hours duration.

* : Tutorials

T : Theory periods per week P: Practical /Drawing Periods per week

C : Total Credits for the subject

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III Year B.Tech BT I-Sem

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TRANSPORT PHENOMENA IN BIOPROCESSES

Unit I: Momentum Transport-I

Mechanism of Momentum Transport: Newton's Law of Viscosity, Non-Newtonian fluids, theory of viscosity of liquids, time dependant viscosity, viscosity measurement (cone-and-plate viscometer, coaxial cylinder rotary viscometer, impeller viscometer), use of viscometers with biological reaction fluids, rheological properties of fermentation broth, factors affecting broth viscosity (cell concentration, cell morphology, osmotic pressure, product and substrate concentration), Velocity distribution in laminar flow and turbulent flow

Unit II: Momentum Transport-II

Equation of change for isothermal system (equation of continuity, equation of motion, equation of mechanical energy), interphase transport in isothermal systems (friction factors for flow in tubes and in packed columns) mixing, mixing mechanism, power requirements in ungasged Newtonian and Non Newtonian fluids, gassed fluids, interaction between cell and turbulent Eddies, operating conditions for turbulent shear damage. Macroscopic Balances- mass, momentum and mechanical energy balances.

Unit III: Energy Transport-I

Thermal conductivity and the mechanisms of energy transport- measurement of thermal conductivity, Fourier's law, steady state conduction, analogy between heat and momentum transfer

Unit IV: Energy Transport-II

Temperature distribution with more than one independent variables- heating in a semi infinite and finite slab, temperature distribution in turbulent flow- reference to stirred tank reactor, relationship between heat transfer, cell concentrations and stirring conditions

Unit V: Mass Transport I

Diffusivity, theory of diffusion, analogy between mass heat and momentum transfer, role of diffusion in bioprocessing, film theory, concentration distribution with more than one independent variable- unsteady diffusion, boundary layer theory, concentration distribution in turbulent flow- Corrsin equation

Unit VI: Mass Transport II

Definition of binary mass transfer coefficients, transfer coefficients at high mass transfer rates- boundary layer theory, penetration theory

Unit VII: Mass Transport III

Convective mass transfer, Liquid -solid mass transfer, liquid-liquid mass transfer, gas-liquid mass transfer

Unit VIII: Oxygen Transport

Oxygen uptake in cell cultures, Factors affecting cellular oxygen demand, oxygen transfer from gas bubbles to aerobic culture, oxygen transfer in fermentors- bubbles, factors affecting oxygen transport- sparging, stirring, medium properties, antifoam agents, temperature, mass transfer correlations, measurements of $k_L a$ - oxygen balance method, dynamic method.

Note: In all units relevant basic numerical problems should be practiced

TEXT BOOKS

- 1 R.B.Bird, W.E.Stewart, E.N.Lightfoot, Transport Phenomena, John wiley and sons, Singapore , 1994
- 2 P.M.Doran, Bioprocess Principles, Academic Press, 1995
- 3 Harvey W. Blanch, Douglas S. Clark Biochemical Engineering, Marcecel, Dekker, 2007.

REFERENCE BOOK

- 1 M.L.Shuler and F. Kargi, Bioprocess Engineering: Basic concepts, 2nd edition, Prentice Hall of India, 2003

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BIOCHEMICAL REACTION ENGINEERING -I

UNIT I: Fundamentals of reaction engineering

Concept of order, molecularity of a reaction, searching a mechanism for a reaction, evaluation of rate constants, factors affecting reaction rates- pH, temperature using Arrhenius equation.

Unit II: Reactions involving cells-I

Growth Kinetics- batch, fed-batch and continuous mode of operation in reaction system, evaluation of kinetic parameters Monod's equation- parameters, death rate of cell-batch and continuous sterilization.

UNIT III: Reactions involving cells-II

Influence of cell age distribution on growth kinetics, effect of inhibitors, substrate inhibition, Models for inhibition kinetics, Evaluation of parameters in Han-Levenspiel model.

Unit IV: Reactions involving cells-III

Stoichiometry of cell growth and product formation- elemental and available electron balances, degrees of reduction, maintenance coefficient, online data analysis for measurement of biochemical parameters, state and parameter estimation technique.

UNIT V: Multiple Reactions

Parallel series, series – parallel reactions, calculation of yield and selectivity, role of thermodynamic parameters, metabolic flux analysis, basic concepts of structured model and introduction to cybernetic models, Design principles- non isothermal reactions and pressure effects, concepts of residence time distribution, micromixing and macromixing

Unit VI: Mechanisms and Kinetics of Enzyme Action

Mechanisms of Enzyme Action; Concept of active site and energetics of enzyme Kinetics, substrate complex formation; Specificity of enzyme action; Kinetics of single substrate reactions; turnover number; estimation of Michaelis-Menten parameters. Importance of K_M , Multi-substrate reaction mechanisms and kinetics. Types of Inhibition- kinetic models; Substrate and Product Inhibition; Allosteric regulation of enzymes; Deactivation kinetics.

Unit VII: Enzyme Immobilization

Physical and Chemical techniques for enzyme Immobilization - adsorption. matrix entrapment, encapsulation. cross-linking. covalent binding - examples; Advantages and disadvantages of different Immobilization techniques. overview of applications of immobilized enzyme systems, effect of pH, temperature on immobilized reaction kinetics.

Unit VIII: Mass Transfer Effects In Immobilized Enzyme Systems and Design of Enzyme Reactors

Analysis of Film and Pore Diffusion Effects on kinetics of Immobilized Enzyme Reactions; Formulation of dimensionless groups and calculation of Effectiveness Factors, Thiele modulus

Note: In all units relevant basic numerical problems should be practiced.

TEXT BOOKS:

- Harvey W. Blanch, Douglas S. Clark Biochemical Engineering, Marcel Dekker, 2007.
O.Levenspiel. Chemical Reaction Engineering 3ed edition, Wiley, New York, 1999.
P.M.Doran Bioprocess Engineering principles, Academic Press, London, 1995.
D.G.Rao, Introduction to Biochemical Engineering, McGraw-Hill, 2005
K.A. Gavhane, Chemical Reaction Engineering –I, Nirali Prakashan, 2006
J. Nielsen, J. Villadsen and G. Liden, Bioreaction Engineering Principles, Springer International, 2nd edition, 2003.
7. G.Hammes, Thermodynamics and kinetics for the biological sciences, Wiley – VCH, 2000

REFERENCES:

1. H. Scott Fogler, Elements of Chemical Reaction Engineering, II Edition, Prentice Hall of India Pvt. Ltd.
2. J.M. Smith, Chemical Engineering Kinetics, McGraw Hill, 1981.
3. M.L. Shuler and F. Kargi Bioprocess Engineering: basic concepts.
 4. H.J. Fromm Initial rate Enzyme kinetics, Springer-Verlag. Berlin 1975.

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BASIC INDUSTRIAL AND ENVIRONMENTAL BIOTECHNOLOGY

Unit I : Production of Primary Metabolites

A brief outline of processes for the production of some commercially important Organic acids (e.g. citric acid, lactic acid, acetic acid, gluconic acid.); Amino acids (Glutamic acid, lysine, aspartic acid&Phenylalanine); and Alcohols (ethanol, 2,3- butanediol)

UNIT II: Secondary Metabolites :

Study of production processes for various classes of low molecular weight secondary metabolites: Antibiotics-beta-lactams (Penicillins), semi synthetic Pencillins and Cephalosporins amino-glycosides (streptomycin), macrolids (erythromycin), quinines, and aromatics. Vitamin (B12) and Steroids, dual or multiple fermentation.

Unit III: Production of Commercially Important Enzymes

Proteases, Amylases Lipases, Cellulases, Pectinases, Isomerases and other commercially important. Enzymes for the food pharmaceutical industries;

UNIT IV : Recombinant Proteins

Production of recombinant proteins (Insulin, Interleukin & Interferon's) having therapeutic and diagnostic applications; production of vaccines.

Unit V : Bio products and other Processes

Natural Biopreservatives (Nisin), and Biopolymers (Xanthan Gum and PHB); Single Cell Protein, Racemically-pure Drug Intermediates, Steroid Bioconversions; High -Fructose Corn syrup; Bioconversion of Vegetable Oils, Bioleaching.

Unit VI : Biological treatment of waste Water – Aerobic and Anaerobic Systems

Biological processes for domestic and industrial waste water treatments; Aerobic systems - activated sludge process, trickling filters, biological filters, rotating biological contractors (RBC), Fluidized bed reactor (FBR), expanded bed reactor, Inverse fluidized bed biofilm reactor (IFBBR) packed bed reactors air- sparged reactors ; Anaerobic Systems - contact digesters, packed column reactors, UASB.

Unit VII: Bioremediation

Introduction, constraints and priorities of Bioremediation, Biostimulation of Naturally occurring microbial activities, Bioaugmentation, in situ, ex situ, intrinsic & engineered bioremediation, Solid phase bioremediation - land farming, prepared beds, soil piles, Phytoremediation. Composting, Bioventing & Biosparging; Liquid phase bioremediation - suspended bioreactors, fixed biofilm reactors.

Unit VIII: Hazardous Waste Management

Introduction - Xenobiotic compounds, recalcitrance. hazardous wastes - biodegradation of Xenobiotics . Biological detoxification - hazardous waste management with at least 3 – 4 Examples.

TEXT BOOKS:

Biotechnology, 3rd edition by John E. Smith. Cambridge low price editions.

Industrial Microbiology: - J. E. Casida;

3 Environmental Biotechnology by S. K. Agarwal

4 Biodegradation & Bioremediation (1999), Martin Alexander, Academic press.

REFERENCES:

1. Microbiology: - Prescott and Dunn.

2. Microbial biotechnology: Glazer, A.N. and Nikaido, H. 1995 W.H. Freeman & Company, New York.

3. Industrial Microbiology:- A. H. Patel., Stanier R. Y., Ingram J.L., Wheelis M.L., Painter R.R., General Microbiology McMillan Publications, 1989.

4. Foster C.F., John Ware D.A., Environmental Biotechnology, Ellis Horwood Ltd., 1987.

5. Karrely D., Chakrabarty K., Omen G.S., Biotechnology and Biodegradation,

6. Advances in Applied Biotechnology Series, Vol.4, Gulf Publications Co. London, 1989.

7. Bioremediation engineering; design and application 1995 John. T. Cookson, Jr. Mc Graw Hill, Inc.

8. Environmental Biotechnology by A.K. Chatterjee

9. Environmental Biotechnology by S.N. Jogdand Himalaya Publishing

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GENETIC ENGINEERING

Unit I: Gene Regulation and Expression in Prokaryotes

Lactose, Arabinose and Tryptophan operons, Repressors and activator, Sigma switch in *Bacillus subtilis*.

Unit II: Gene Regulation in Eukaryotic system

Gene regulation in Eukaryotic system, Repetitive DNA, Gene rearrangement, Promoters, enhancer elements, gene amplification.

Unit III: Plasmids, Transposons / Vectors for Gene Transfers

Plasmids: Definition, types, Identification, classification and purifications and transfer of Plasmids. Host restriction in transfer. Transposable elements: Definition, detection of transposition in bacteria, types of bacterial transposons, mechanisms of transposition and excision, applications of transposons. Retrotransposons.

UNIT IV: DNA Technology

Purification of genomic DNA from living cells, Manipulation of purified DNA; construction of prototype vector (pBR 322), different types of cloning vectors (plasmid – pUC 19, ? phage, cosmid, M13). Enzymes involved in genetic engineering; cloning strategies, Introduction of DNA into living cells. Methods of Gene transfer, Restriction mapping.

UNIT – V Expression and Detection of clones

Detection of clones and its expression: Expression of cloned genes in yeast & *E. coli*. Blot analysis - Southern, Northern & Western blot; dot and slot blot. Immunological techniques. DNA methylation, DNA hybridization. Genomic and cDNA library construction and application. DNA sequencing.

Unit VI: PCR and its application

Principles, designing of primers, PCR methodology, RT - PCR, multiplex PCR, identification of PCR product, application of PCR technology.

Unit VII: Molecular markers

Molecular markers: RFLP, RAPD, AFLP, 16s r-RNA typing, gene chip and micro array; applications in disease profile

Unit VIII: Applications of r-DNA Technology

Gene cloning in medicine (Insulin, Blood clotting factor VIII) High level expression of proteins in different host systems (*E. coli*, yeast, Insect, mammalian cells) Limitation and advantages and novel technologies- for generation of transgenic animals. Introduction to Gene therapy (Ex vivo & In vivo), case study of ADA as an example. Advantages and limitations of Gene therapy.

TEXT BOOKS:

1. Old RW, Primrose SB, principles of Gene manipulation, An introduction to Genetic engineering, Blackwell Scientific Publications, 1993
2. T.A. Brown, Gene Cloning.

REFERENCES:

1. Ansubel FM., Brent A, Kingston AE, Moore DO, Current protocols in Molecular Biology, Greene Publishing Associates, NY, 1988.
2. Berger SL, Kimmer AR, Methods in Enzymology, Vol 152, Academic Press, 1987.
3. Molecular Cell Biology – Gerald Carp.

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PLANT BIOTECHNOLOGY

UNIT I TISSUE CULTURE

Introduction to cell and tissue culture; Tissue culture media (composition, preparation); Initiation and maintenance of callus and cell suspension culture, Somatic embryogenesis, organogenesis; Protoplast isolation culture and fusion;

UNIT II TISSUE CULTURE APPLICATIONS I

Production of haploids, Somaclonal variations, Germplasm conservation (Cryopreservation);

UNIT III TISSUE CULTURE APPLICATIONS II

Production of secondary metabolites from plant cell cultures; Processes for enhancing the production of secondary metabolites. Technology of plant cell culture for production of chemicals; Bioreactors systems and models for mass cultivation of plant cells;

UNIT IV PLANT TRANSFORMATION TECHNOLOGY

Agrobacterium mediated gene transfer; Agrobacterium based vectors, viral vectors and their application. Direct gene transfer methods; chemical methods, electroporation, microinjection, particle bombardment.

UNIT V PLANT GENETIC ENGINEERING FOR PRODUCTIVITY AND PERFORMANCE I (BIOTIC STRESS)

Herbicide resistance, Insect resistance, Disease resistance, virus resistance,.

UNIT VI PLANT GENETIC ENGINEERING FOR PRODUCTIVITY AND PERFORMANCE II (ABIOTIC STRESS)

Abiotic stress tolerance ;Drought, temperature, salt .

UNIT VII MOLECULAR FARMING & INDUSTRIAL PRODUCTS

Application of Plant biotechnology for the production of quality oil, Industrial enzymes, Therapeutic Proteins , Antigens (edible vaccine) and plantibodies.

UNIT VIII METABOLIC ENGINEERING

Metabolic engineering for plant primary metabolites and secondary metabolites.

TEXT BOOKS:

1. Roberta Smith, Plant Tissue Culture: Techniques and Experiments. 2nd ed., Academic Press, 2000.
2. Bhojwani, S.S. and Rajdan, Plant Tissue Culture: Theory and Practice. 2004

REFERENCES:

1. Crispeels, M.J. and Sadava, D.E., Plants, Genes and Crop Biotechnology, Jones and Bartlett Publishers (2nd Edition), 2003.
2. Bhowjwani, S.S., Plant Tissue Culture: Application and Limitations. Amsterdam, Elsevier,1990.
3. Charles Cunningham and Andrew J.R. Porter, Recombinant Proteins from Plants: Production and Isolation of Clinically Useful Compounds (Methods in Biotechnology), Humana Press, 1997.
4. Bernard R. Glick and John E. Thompson, Methods in Plant Molecular Biology and Biotechnology, CRC Press, 1993.
5. I. Potrykus and G. Spangenberg, , Gene Transfer to Plants (Springer Lab Manual), Springer Verlag, 1997.
6. Peter M. Gresshoff, Plant Genome Analysis: Current Topics in Plant Molecular Biology. CRC Press, 1994.
7. John Hammond, Peter McGarvey, Vidadi Yusibov, Plant Biotechnology: New Products and Applications, Springer Verlag, 1999.

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MANAGERIAL ECONOMICS AND FINANCIAL ANALYSIS

Unit I Introduction to Managerial Economics:

Definition, Nature and Scope of Managerial Economics–Demand Analysis: Demand Determinants, Law of Demand and its exceptions.

Unit II Elasticity of Demand: Definition, Types, Measurement and Significance of Elasticity of Demand. Demand Forecasting, Factors governing demand forecasting, methods of demand forecasting (survey methods, statistical methods, expert opinion method, test marketing, controlled experiments, judgmental approach to demand forecasting)

Unit III Theory of Production and Cost Analysis: Production Function – Isoquants and Isocosts, MRTS, Least Cost Combination of Inputs, Cobb-Douglas Production function, Laws of Returns, Internal and External Economies of Scale.
Cost Analysis: Cost concepts, Opportunity cost, Fixed vs. Variable costs, Explicit costs Vs. Implicit costs, Out of pocket costs vs. Imputed costs. Break-even Analysis (BEA)-Determination of Break-Even Point (simple problems)- Managerial Significance and limitations of BEA.

Unit IV Introduction to Markets & Pricing Policies:

Market structures: Types of competition, Features of Perfect competition, Monopoly and Monopolistic Competition. Price-Output Determination in case of Perfect Competition and Monopoly.

Objectives and Policies of Pricing- Methods of Pricing: Cost Plus Pricing, Marginal Cost Pricing, Sealed Bid Pricing, Going Rate Pricing, Limit Pricing, Market Skimming Pricing, Penetration Pricing, Two-Part Pricing, Block Pricing, Bundling Pricing, Peak Load Pricing, Cross Subsidization.

Unit V Business & New Economic Environment: Characteristic features of Business, Features and evaluation of Sole Proprietorship, Partnership, Joint Stock Company, Public Enterprises and their types, Changing Business Environment in Post-liberalization scenario.

Unit VI Capital and Capital Budgeting: Capital and its significance, Types of Capital, Estimation of Fixed and Working capital requirements, Methods and sources of raising finance.
Nature and scope of capital budgeting, features of capital budgeting proposals, Methods of Capital Budgeting: Payback Method, Accounting Rate of Return (ARR) and Net Present Value Method (simple problems)

Unit VII Introduction to Financial Accounting: Double-Entry Book Keeping, Journal, Ledger, Trial Balance- Final Accounts (Trading Account, Profit and Loss Account and Balance Sheet with simple adjustments).

Unit VIII Financial Analysis through ratios: Computation, Analysis and Interpretation of Liquidity Ratios (Current Ratio and quick ratio), Activity Ratios (Inventory turnover ratio and Debtor Turnover ratio), Capital structure Ratios (Debt- Equity ratio, Interest Coverage ratio), and Profitability ratios (Gross Profit Ratio, Net Profit ratio, Operating Ratio, P/E Ratio and EPS).

TEXT BOOKS:

1. Aryasri: Managerial Economics and Financial Analysis, 2/e, TMH, 2005.
2. Varshney & Maheswari: Managerial Economics, Sultan Chand, 2003.

REFERENCES:

1. Ambrish Gupta, Financial Accounting for Management, Pearson Education, New Delhi.
2. H. Craig Peterson & W. Cris Lewis, Managerial Economics, PHI, 4th Ed.
3. Suma Damodaran, Managerial Economics, Oxford University Press.
4. Lipsey & Chrystel, Economics, Oxford University Press.
5. S. A. Siddiqui & A. S. Siddiqui, Managerial Economics & Financial Analysis, New age International Space Publications.
6. Domnick Salvatore: Managerial Economics In a Global Economy, 4th Edition, Thomson.
7. Narayanaswamy: Financial Accounting—A Managerial Perspective, PHI.
8. Raghunatha Reddy & Narasimhachary: Managerial Economics& Financial Analysis, Scitech.
9. S.N.Maheswari & S.K. Maheswari, Financial Accounting, Vikas.
10. Truet and Truet: Managerial Economics:Analysis, Problems and Cases, Wiley.
11. Dwivedi:Managerial Economics, 6th Ed., Vikas.

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MOLECULAR BIOLOGY AND GENETIC ENGINEERING LAB

1. Isolation of Plant and Bacterial Genomic DNA and Plasmid DNA.
2. Agarose Gel Electrophoresis.
3. Restriction Enzyme digestion.
4. Demonstration Chemical mutagenesis.
5. Isolation and visualization of plasmid on Agarose gel.
6. Restriction mapping and ligation.
7. Transformation, screening for recombinants.
8. Characterization of secondary metabolites by Polyacrylamide gel Electrophoresis. Silver staining of protein gels.
9. Blotting Techniques.
10. Expression of Beta – galactosidase and assay.
11. Cloning of DNA into plasmid vector.

REFERENCES:

Current protocols in Molecular Biology by Maniatis.

EQUIPMENTS:

Autoclave.
Laminar air flow chamber.
Water bath
Balance.
Microfuge.
Micropipettes
Submarine gel electrophoresis unit with power pack.
U.V. Transilluminator.
Vertical slab gel electrophoresis equipment.

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ADVANCED ENGLISH COMMUNICATION SKILLS LAB

1. Introduction

The introduction of the English Language Lab is considered essential at 3rd year level. At this stage the students need to prepare themselves for their careers which may require them to listen to, read, speak and write in English both for their professional and interpersonal communication in the globalised context.

The proposed course should be an integrated theory and lab course to enable students to use 'good' English and perform the following:

- Gather ideas and information, to organise ideas relevantly and coherently.
- Engage in debates.
- Participate in group discussions.
- Face interviews.
- Write project/research reports/technical reports.
- Make oral presentations.
- Write formal letters.
- Transfer information from non-verbal to verbal texts and vice versa.
- To take part in social and professional communication.

2. Objectives:

This Lab focuses on using computer-aided multimedia instruction for language development to meet the following targets:

- To improve the students' fluency in English, through a well-developed vocabulary and enable them to listen to English spoken at normal conversational speed by educated English speakers and respond appropriately in different socio-cultural and professional contexts.
- Further, they would be required to communicate their ideas relevantly and coherently in writing.

3. Syllabus:

The following course content is prescribed for the Advanced Communication Skills Lab:

- Functional English - starting a conversation – responding appropriately and relevantly – using the right body language – role play in different situations.
- Vocabulary building – synonyms and antonyms, word roots, one-word substitutes, prefixes and suffixes, study of word origin, analogy, idioms and phrases.
- Group Discussion – dynamics of group discussion, intervention, summarizing, modulation of voice, body language, relevance, fluency and coherence.
- Interview Skills – concept and process, pre-interview planning, opening strategies, answering strategies, interview through tele and video-conferencing.
- Resume' writing – structure and presentation, planning, defining the career objective, projecting ones strengths and skill-sets, summary, formats and styles, letter-writing.
- Reading comprehension – reading for facts, guessing meanings from context, scanning, skimming, inferring meaning, critical reading.
- Technical Report writing – Types of formats and styles, subject matter – organization, clarity, coherence and style, planning, data-collection, tools, analysis.

4. Minimum Requirement:

The English Language Lab shall have two parts:

- i) **The Computer aided Language Lab** for 60 students with 60 systems, one master console, LAN facility and English language software for self- study by learners.
- ii) **The Communication Skills Lab** with movable chairs and audio-visual aids with a P.A System, a T. V., a digital stereo –audio & video system and camcorder etc.

System Requirement (Hardware component):

Computer network with Lan with minimum 60 multimedia systems with the following specifications:

- i) P – IV Processor
 - a) Speed – 2.8 GHZ
 - b) RAM – 512 MB Minimum
 - c) Hard Disk – 80 GB
- ii) Headphones of High quality

5. Suggested Software:

The software consisting of the prescribed topics elaborated above should be procured and used.

Suggested Software:

- **Clarity Pronunciation Power** – part II
- **Oxford Advanced Learner's Compass**, 7th Edition
- **DELTA's key to the Next Generation TOEFL Test: Advanced Skill Practice.**
- **Lingua TOEFL CBT Insider**, by Dreamtech
- **TOEFL & GRE**(KAPLAN, AARCO & BARRONS, USA, Cracking GRE by CLIFFS)
- **The following software from 'train2success.com'**
 - **Preparing for being Interviewed,**
 - **Positive Thinking,**
 - **Interviewing Skills,**
 - **Telephone Skills,**
 - **Time Management**
 - **Team Building,**
 - **Decision making**

- **English in Mind**, Herbert Puchta and Jeff Stranks with Meredith Levy, Cambridge

6. Books Recommended:

1. **Effective Technical Communication**, M. Ashraf Rizvi, Tata Mc. Graw-Hill Publishing Company Ltd.
2. **A Course in English communication** by Madhavi Apte, Prentice-Hall of India, 2007.
3. **Communication Skills** by Leena Sen, Prentice-Hall of India, 2005.
4. **Academic Writing- A Practical guide for students** by Stephen Bailey, Rontledge Falmer, London & New York, 2004.
5. **English Language Communication : A Reader cum Lab Manual** Dr A Ramakrishna Rao, Dr G Natanam & Prof SA Sankaranarayanan, Anuradha Publications, Chennai
6. **Body Language- Your Success Mantra** by Dr. Shalini Verma, S. Chand, 2006.
7. **DELTA's key to the Next Generation TOEFL Test: Advanced Skill Practice**, New Age International (P) Ltd., Publishers, New Delhi.
8. Books on **TOEFL/GRE/GMAT/CAT** by Barron's/cup
9. **IELTS series with CDs** by Cambridge University Press.
10. **Technical Report Writing Today** by Daniel G. Riordan & Steven E. Pauley, Biztantra Publishers, 2005.
11. **Basic Communication Skills for Technology** by Andra J. Rutherford, 2nd Edition, Pearson Education, 2007.
12. **Communication Skills for Engineers** by Sunita Mishra & C. Muralikrishna, Pearson Education, 2007.
13. **Objective English** by Edgar Thorpe & Showick Thorpe, 2nd edition, Pearson Education, 2007.
14. **Cambridge Preparation for the TOEFL Test** by Jolene Gear & Robert Gear, 4th Edition.
15. **Technical Communication** by Meenakshi Raman & Sangeeta Sharma, Oxford University Press.

DISTRIBUTION AND WEIGHTAGE OF MARKS:

Advanced Communication Skills Lab Practicals:

1. The practical examinations for the English Language Laboratory practice shall be conducted as per the University norms prescribed for the core engineering practical sessions.
2. For the English Language lab sessions, there shall be a continuous evaluation during the year for 25 sessional marks and 50 End Examination marks. Of the 25 marks, 15 marks shall be awarded for day-to-day work and 10 marks to be awarded by conducting Internal Lab Test(s). The End Examination shall be conducted by the teacher concerned with the help of another member of the staff of the same department of the same institution.

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BIOINFORMATICS

UNIT I: INTRODUCTION TO BIOINFORMATICS

Scope of Bioinformatics, Elementary commands and protocols, ftp, telnet, http. Primer on information theory.

UNIT-II: INTRODUCTION TO HOMOLOGY

Introduction to Homology (with special mention to Charles Darwin, Sir Richard Owen, Willie Henning, Alfred Russel Wallace).

UNIT III: SPECIAL TOPICS IN BIOINFORMATICS

DNA mapping and sequencing, Map alignment, Large scale sequencing methods Shotgun and Sanger method.

UNIT IV : SEQUENCING ALIGNMENT AND DYNAMIC PROGRAMMING

Heuristic Alignment algorithms. Global sequence alignments-Neddleman-Wunsch Algorithm Smith-Waterman Algorithm-Local sequence alignments (Amino acid substitution Matrices (PAM, BLOSUM).

UNIT V: PRIMARY DATABASE AND THEIR USE

Introduction to Biological databases, Organization and management of databases. Searching and retrieval of information from the World Wide Web. Structure databases - PDB (Protein Data Bank), Molecular Modeling Databases (MMDB). Primary Databases NCBL,EMBL, DDBJ.

UNIT-VI: SECONDARY DATABASES

Introduction to Secondary Databases Organization and management of databases Swissprot, PIR,KEGG

UNIT-VII: BIOCHEMICAL DATA BASES

Introduction to BioChemical databases-organization and Management of databases. KEGG, EXGESCY, BRENDA, WIT.

UNIT VIII: EVOLUTIONARY TREES AND PHYLOGENY

Multiple sequence alignment and phylogenetic analysis.

TEXT BOOKS:

1. Bioinformatics Basics. Applications in Biological Science and Medicine by Hooman H. Rashidi and Lukas K.Buehler CAC Press 2000.
2. Algorithms on Strings Trees and Sequences Dan Gusfiled. Cambridge University Press 1997.

REFERENCES:

1. Bioinformatics: A Machine Learning Approach P. Baldi. S. Brunak, MIT Press 1988.
2. Bioinformatics. David Mount, 2000. CSH Publications
3. Developing Bioinformatics Skills. Cynthia Gibbas & Per Jamberk
4. Genomics and Proteomics-Functional and Computational aspects. Springer Publications. Editor-Sandor Suhai.
5. Bioinformatics- Methods and Protocols-Human Press. Stephen Misener, Stephen A. Krawetz.
6. Computational Biochemistry – C.Stan ,TSAI WILEY Publications.
7. Bioinformatics – A Practical guide to the Analysis of Genes and Proteins – ANDREAS D.BAXEVANIS, B.F. FRANCIS OUELLETTE.
8. Bioinformatics – Principles and Applications – Harshawardhan P.Bal TATA MEGRAW HILL.
9. BLAST : An Essential guide Ian Korf, O'Reilly publishers.
10. Bioinformatics Computer skills Cynthia Gibas O'Reille publishers.

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BIOETHICS, BIO SAFETY AND INTELLECTUAL PROPERTY RIGHTS

UNIT I: BIOETHICS

Introduction to Bioethics. Social and ethical issues in Biotechnology

UNIT II: BIOSAFETY I

Definition of Biosafety. Biosafety for human health and environment. Social and ethical issues.

UNIT III: BIOSAFETY II

Use of genetically modified organisms and their release in to the environment. Special procedures for r-DNA based products

UNIT IV: REGULATORY AFFAIRS

Regulatory requirements for drugs and Biologics. GLP. GMP

UNIT V: INTELLECTUAL PROPERTY RIGHTS I

Intellectual property rights, and Intellectual Property protection, patents and methods of application of patents,

UNIT VI: INTELLECTUAL PROPERTY RIGHTS II

Trade Secrets copyrights, Trade Marks, legal implications, farmers rights, plant breeder's rights.

UNIT VII: INTELLECTUAL PROPERTY RIGHTS III

International and National conventions on biotechnology and related areas.

UNIT VIII

WTO guidelines

TEXT BOOKS:

1. Sasson A, Biotechnologies and Development, UNESCO Publications, 1988.
2. Sasson A. Biotechnologies in developing countries present and future, UNESCO publishers, 1993.

REFERENCE:

1. Singh K. Intellectual Property Rights on Biotechnology, BCII, New Delhi.

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DOWNSTREAM PROCESSING

UNIT I: ROLE OF DOWNSTREAM PROCESSING IN BIOTECHNOLOGY

Role and importance of downstream processing in biotechnological processes. Problems and requirements of bioproduct purification. Economics of downstream processing in Biotechnology, cost-cutting strategies, characteristics of biological mixtures, process design criteria for various classes of bioproducts (high volume, low value products and low volume, high Value products)

UNIT-II:

Physico-chemical basis of bio-separation processes. Recent development in product Isolation (for ex. one step purification, reverse Micro cellular extraction on line membrane separation).

UNITIII: PRIMARY SEPARATION AND RECOVER PROCESS

Cell disruption methods for intracellular products, removal of insoluble, biomass (and particulate debris) separation techniques, flocculation and sedimentation, centrifugation and filtration methods.

UNIT IV: MEMBRANE SEPARATIONS

Membrane-based separations (micro and ultrafiltration), theory, design and configuration of membrane separation equipment applications,

UNIT V: ENRICHMENT OPERATIONS

Precipitation methods (with salts, organic solvents, and polymers, extractive separations, aqueous two-phase extraction, supercritical extraction), in situ product removal, integrated bioprocessing.

UNIT VI: ELECTROPHORESIS

Electrophoresis of proteins and nucleic acids, 1D-2D Gels, Types of Electrophoretic techniques (Capillary and Pulse field).

UNIT VII: PRODUCT RESOLUTION / FRACTIONATION

Chromatographic techniques- Paper, TLC, Adsorption, Ion exchange, Gel filtration, affinity chromatographic separation processes, GC, HPLC, FPLC, Chromatofocusing electrophoretic separations.

UNIT VIII: NEW AND EMERGING TECHNOLOGIES

Dialysis, Crystallization Pervaporation, super liquid extraction foam based separation case study with examples for processing of Two Industrial Products (Citric acid / Penicillin and Low volume high value product like recombinant proteins).

TEXT BOOKS:

1. Wankat PC. Rate controlled separations, Elsevier, 1990.
2. Belter PA and Cussler E. Bioseparations, Wiley 1985.

REFERENCES:

1. Product Recovery in Bioprocess Technology, BIOTOL.' Series, VCH, 1990.
2. Asenjo J.M. Separation processes in Biotechnology, 1993, Marcel Dekkera Inc
3. M.R.Ladisich, Bioseparation engineering: Principles, Practice and Economics, Wiley Interscience 2001

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BIOSENSORS AND BIOELECTRONICS

UNIT I: INTRODUCTION

What are Biosensors? Advantages and limitations, various components of biosensors

UNIT II TYPES OF BIOSENSORS

Biocatalysis based biosensors, bioaffinity based biosensors & microorganisms based biosensors, biologically active material and analyte. Types of membranes used in biosensor constructions.

UNIT III: TRANSDUCERS IN BIOSENSORS I

Various types of transducers; principles and applications - Calorimetric, optical, potentiometric / amperometric conductometric/resistometric,

UNIT IV: TRANSDUCERS IN BIOSENSORS II

Piezoelectric, semiconductor, impedimetric, mechanical and molecular electronics based transducers. Chemiluminiscene - based biosensors.

UNIT V: APPLICATION AND USES OF BIOSENSORS I

Biosensors in clinical chemistry, medicine and health care, biosensors for veterinary, agriculture and food

UNIT VI: APPLICATION AND USES OF BIOSENSORS II

Low cost- biosensor for industrial processes for online monitoring; biosensors for environmental monitoring.

UNIT VII: MOLECULAR ELECTRONICS I

Potential advantages & Developments towards a biomolecular computer, development of molecular arrays as memory stores; molecular wires and switches; mechanisms of unit assembly;

UNIT VIII: DESIGN FOR A BIOMOLECULAR PHOTONIC COMPUTER

Assembly of photonic biomolecular memory store; Information processing; commercial prospects for biomolecular computing systems.

TEXT BOOKS:

1. Aboul - Enein, H. V., Stefan, R. and Van Staden, (1999) Chemiluminiscence - based biosensors - An overview crit Rev. Anal. Chem. 29, 323-331.
2. Pearson, J.E. Gill, A., and Vadgama, P. (2000) Analytical aspects of biosensors Ann Clin Biochem 37, 119-145.

REFERENCES:

1. Roger, K.R. and Gerlach, C.L. 1~99. Update on environmental for biosensors. Env. Sci. Techno! 33 500A - 506A.
2. Bilitewski, U. Turner, A.P.F. 2000 Biosensors for environmental monitoring Harwood, Amsterdam.
3. Moses, V and Cape, R.E. 1991, Biotechnology the science and business, Harwood, Academic Publisher London
4. Rogers, K.R. and Mascini, M. 2001. Biosensors for analytical monitoring EPA biosensors group.

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**BIOMATERIAL SCIENCE AND TECHNOLOGY
(Elective I)**

UNIT I: INTRODUCTION

Definition of polymers and biomaterials, functionality, polymer isomerism

UNIT II: SELECTION OF BIOMATERIALS

Selection criteria, fiber folding, membrane lamination, in situ polymerization

UNIT III: BIOLOGICALLY DERIVED BIOMATERIALS

Polyhydroxialkanoates, polylactides- characterization, synthesis in organism and extraction

UNIT IV: MATERIALS FOR TISSUE ENGINEERING

Case studies with regenerated polymers

UNIT V: TRENDS IN BIOCOMPOSITE

Biodiode , polymer coated blood, polymer precursor synthesis and characterization

UNIT VI: IMPROVED FUNCTIONS OF BIOPOLYMERS

Genetic and molecular Biology aspects of synthesis

UNIT VII: FERMENTATIVE PRODUCTION

Biopolyester, microbial polysaccharides, microbial cellulose, bioadhesive, polyglutamic acid

UNIT VIII: OPTIMIZATION OF PRODUCTION KINETICS, SEPARATION

Statistical optimization of probable variables for production of biomaterials, use of reactors, kinetic analysis for production, separation of Biomaterials by cell digestion and extraction

BOOKS:

1. D. Byrom, Biomaterials –novel materials from biological sources, Stockton press, New York, 1991.
2. J.B.Park, Biomaterials science and engineering, Plenum Pulo, 1984.

REFERENCE BOOK:

1. A. Steinbuechel – Biopolymers.

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**CELL SIGNALING
(Elective 1)**

UNIT I: INTRACELLULAR SIGNALING.

Introduction, Receptor-Ligand interactions.

UNIT II: ROLE OF RECEPTORS –I

Extra Cellular Receptors, Coupling to different signal transducing systems.

UNIT III : ROLE OF RECEPTORS –II

Type of intracellular receptors, steroid receptors, structure and function.

UNIT IV:SPECIFIC MOLECULES

Role and functions of G-proteins, CREB proteins, Calcium channels, second messengers-inositol, diacyl glycerol

UNIT V: MECHANISM

Signal transduction, mechanism and involvement of molecules.

UNIT VI: RECEPTORS

Regulations of receptor function,modification and adaptation of cells.

UNIT VII :PATHWAYS

Signal transduction pathways, applications in development and diseases.

UNIT VIII :ROLE OF DEFECTIVE SIGNALING

Development of abnormalities, signal transducing machinery as targets for potential drugs.

Textbooks

1. G.Posil and S.T. Croke, Mechanism of receptor regulations, Plenum Press,1985.
2. R.H Getzenberg and E.E. Bittar, Cell structure and signaling, Elsevier Science, 1997.

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STRUCTURAL BIOLOGY

(Elective - I)

UNIT I: INTRODUCTION

Levels of structures in Biological macromolecules, the chirality of biomolecules, proteins, nucleic acids, carbohydrates and lipids, cofactors, vitamins and hormones.

UNIT II: CONFORMATIONAL ANALYSIS

Forces that determine Protein and Nucleic acid structure, basic problems. Polypeptide chains; geometric, potential energy calculations, observed values for rotation angles, hydrogen bonding, hydrophobic interactions and water structures; ionic interactions, disulphide bonds.

UNIT III: PROTEIN FOLDING

Types of proteins and interactions that govern protein folding, protein structure, The protein globule and hydrophic interactions organized folds, folding mechanisms, membrane proteins, helix-coil transitions,

UNIT IV: BIOMOLECULAR INTERACTIONS

Molecular recognition, supramolecular interactions, Functional importance of Protein-protein and protein-nucleic acid interactions. Specific and non-specific DNA-protein complexes.

UNIT V: STRUCTURAL ANALYSIS OF MACROMOLECULES

Prediction of protein structure; Sequence-structure relationships, Nucleic acids; general characteristics of nucleic acid structure, geometric, glycosidic bond rotational isomers backbone rotational isomers and ribose puckering forces stabilizing ordered forms, base pairing, base stacking; tertiary structure of nucleic acids.

UNIT VI: KINETICS OF LIGAND INTERACTIONS:

Biochemical Kinetics studies, uni-molecular reactions, simple bimolecular multiple intermediates, steady state kinetics, catalytic efficiency relaxation spectrometry, ribonuclease as an example.

UNIT VII: TECHNIQUES FOR THE STUDY OF BIOLOGICAL STRUCTURE & FUNCTION I

Size and shape of micro molecules: photons, chromophores, transition dipole moments, absorbance, and concentration. circular dichroism: molecular chirality and structural transitions of macromolecules, methods of direct visualization macromolecules as hydrodynamic particles - macromolecular diffusion ultra centrifugation viscometry.

UNIT VIII: TECHNIQUES FOR THE STUDY OF BIOLOGICAL STRUCTURE & FUNCTION II

X- ray crystallography; determination of molecular structures, X- ray fiber diffraction electron microscopy; neutron scattering - light scattering, NMR spectroscopy.

Text Book:

1. Tinoco, I., Jr., Sauer, K., Wang, J. C., & Puglisi, J. D. (2001) Physical Chemistry: Principles and Applications in Biological Sciences, 4th ed. Prentice Hall.

References :

1. Introduction to Protein Architecture, by A.M. Lesk
2. Introduction to Protein Structure, by Branden and Tooze

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CANCER BIOLOGY

(Elective-I)

UNIT I: FUNDAMENTALS OF CANCER BIOLOGY

Regulation of Cell cycle, mutations that cause changes in signal molecules, effects on receptor, signal switches,

UNIT II: TUMOR SUPPRESSION

tumour suppressor genes, modulation of cell cycle in cancer. Different forms of cancers, Diet and cancer.

UNIT III: PRINCIPLES OF CARCINOGENESIS I

Chemical Carcinogenesis, Metabolism of Carcinogenesis, Natural History of Carcinogenesis, Targets of Chemical Carcinogenesis

UNIT IV: PRINCIPLES OF CARCINOGENESIS II

Principles of Physical Carcinogenesis, X - Ray radiation - mechanism of radiation Carcinogenesis.

UNIT V: MOLECULAR CELL BIOLOGY OF CANCER

Oncogenes, Identification of Oncogenes, Retroviruses and Oncogenes, detection of Oncogenes, Growth Factor and Growth Factor receptors that are Oncogenes. Oncogenes / Proto Oncogene activity. Growth factors related to transformations.

UNIT VI: PRINCIPLES OF CANCER METASTASIS

Clinical significances of invasion, heterogeneity of metastatic phenotype, Metastatic cascade, Basement Membrane disruption, Three-step theory of Invasion, Proteinases and tumour cell invasion.

UNIT VII: DETECTION OF CANCER

Detection of Cancers, Prediction of aggressiveness of Cancer, Advances in Cancer detection.

UNIT VIII: NEW MOLECULES FOR CANCER THERAPY

Different forms of therapy, Chemotherapy, radiation Therapy, and Immuno therapy: advantages and limitations.

TEXT BOOKS

1. Maly B.W.J. Virology a practical approach, IRL Press, Oxford, 1987.
2. Scientific Publications. Oxford, 1988. An Introduction to Cellular and Molecular Biology of Cancer, Oxford Medical publications, 1991.

REFERENCE:

1. Dunmock N.J and Primrose.S.B., Introduction to modern Virology, Blackwel

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**CREATIVITY, INNOVATION AND PRODUCT DEVELOPMENT
(Elective - II)**

UNIT I INTRODUCTION

The process of technological innovation, factors contributing to successful technological innovation

UNIT II CREATIVITY

The need for creativity and innovation, creativity and problem solving, brain storming- different techniques.

UNIT III PROJECT SELECTION AND EVALUATION

Collection of ideas and purpose of project.- Selection criteria - screening ideas for new products (evaluation techniques).

UNIT IV NEW PRODUCT DEVELOPMENT

Research and new product development Patents - patent search

UNIT V: PATENT LAWS

Patent laws International code for patents - Intellectual property rights (IPR).

UNIT VI NEW PRODUCT PLANNING I

Design of proto type - testing - quality standards

UNIT VII NEW PRODUCT PLANNING II

Marketing research - introducing new products. GMP

UNIT VIII LABORATORY

Creative design - Model Preparation - Testing – cost – evaluation, Patent application- GLP.

TEXT BOOKS

1. HARRY B.WATTON - New Product Planning. Prentice-Hall Inc. 1992.
2. P.N.KHANDWALLA - Fourth Eye (Excellence through Creativity) - Wheeler Publishing, Allahabad, 1992.

REFERENCES

1. HARRY NYSTROM - Creativity and innovation -John Wiley & Sons, 1979.
2. BRAIN TWISS, Managing technological innovation, Pitman Publishing Ltd, 1992.
3. I.P.R. Bulletins. TIFAC, New Delhi, 1997.

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**NANO BIOTECHNOLOGY
(Elective II)**

UNIT I: BASIC CONCEPT

Definition of nano scale with reference to biosystems, Scope and future prospects.

UNIT II: TOOLS OF NANOSCIENCE

Scanning probe instrument, spectroscopy, electron microscopy.

UNIT III: TOOLS FOR NANOSTRUCTRE

Molecular synthesis, Self assembly, Polymerisation, Nanoscale lithography, e-beam lithography.

UNIT IV: SMART MATERIALS

Heterogenous nano structre and composites, nanoscale biostructres.

UNIT V: HYBRID COMPUTERS

Protein-hybrid computers, role of genetically engineered polymer proteins.

UNIT VI: DIRECTED SYNTHESIS

Molecular biology of biosynthesis and molecular design.

UNIT VII: APPLICATIONS

Drugs-Photodynamic therapy, molecular motors, neuroelecronic interphases, development of nanoluminiscent tags.

UNIT VIII: BIOSYNTHESIS OF DESIGNER COMPOUNDS

Designer biopolymers, Procollagen, DNA Polynode, RNA topoisomerase, Protein –magnetic materials.

Textbooks:

1. M.Ratner and D.Ratner, Nanotechnology –a gentle introduction to the next big idea, Pearson education , 2007.
2. R.R.Birge, Proetin based computers, Scientific American , 1995.

References:

1. L.E.Foster, Nanotechnology-Science, Innovation and opportunity , Person eduction inc, 2007.

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**METABOLIC ENGINEERING
(Elective – II)**

UNIT I : INTRODUCTION

Identification of metabolic regulation is a key point in metabolic engineering.

Basic concepts of Metabolic Engineering – Overview of cellular metabolism – Different models for cellular reactions, induction – Jacob Monod model and its regulation, Differential regulation by isoenzymes, Feed back regulation.

UNIT II : SYNTHESIS OF PRIMARY METABOLITES

Amino acid synthesis pathways and its regulation at enzyme level and whole cell level, Alteration of feed back regulation, Limiting accumulation of endproducts.

UNIT III : BIOSYNTHESIS OF SECONDARY METABOLITES

Regulation of secondary metabolite pathways, precursor effects, prophase, idiophase relationship, Catabolite regulation by passing control of secondary metabolism, producers of secondary metabolites, applications of secondary metabolites.

UNIT IV : BIOCONVERSIONS

Applications of Bioconversions, Factors affecting bioconversions, Specificity, Yields, Co metabolism, Product inhibition, mixed or sequential bioconversions, Conversion of insoluble substances.

UNIT V : REGULATION OF ENZYME PRODUCTION

Strain selection, Genetic improvement of strains, Gene dosage, metabolic pathway manipulations to improve fermentation, Feed back repression, Catabolite Repression, optimization and control of metabolic activities. The modification of existing - or the introduction of entirely new - metabolic pathways

UNIT VI : METABOLIC FLUX

Integration of anabolism and catabolism, metabolic flux distribution analysis, bioprocess, material balance, kinetic types, equilibrium reaction. Experimental determination method of flux distribution, Metabolic flux analysis and its applications, Thermodynamics of cellular processes

UNIT VII : METABOLIC ENGINEERING WITH BIOINFORMATICS

Metabolic pathway modeling, Analysis of metabolic control and the structure metabolic networks, Metabolic pathway synthesis algorithms,

UNIT VIII : APPLICATIONS OF METABOLIC ENGINEERING

Application in pharmaceuticals, chemical bioprocess, food technology, agriculture, environmental bioremediation and biomass conversion.

TEXT BOOKS:

1. Wang, D.I.C Cooney C.L., Demain A.L., Dunnill P., Humphrey A.E. Lilly M.D., Fermentation and Enzyme Technology, John Wiley and sons 1980.
2. Stanbury P.F., and Whitaker A., Principles of Fermentation Technology, Pergamon Press, 1984.

References :

- Zubay G., Biochemistry, Macmillan Publishers, 1989.
<http://ocw.osaka-u.ac.jp/contents/19/ME040512.pdf> For unit VI & VII
<http://ocw.osaka-u.ac.jp/contents/19/ME040421.pdf> For unit VI
<http://ocw.osaka-u.ac.jp/contents/19/ME040526.pdf> For unit VII
<http://ocw.osaka-u.ac.jp/contents/19/ME040602.pdf> For unit VI & VII
<http://www.bioinfo.de/isb/gcb01/poster/hurlebaus.html>
How will bioinformatics influence metabolic engineering? Biotechnol Bioeng. 1998 Apr 20-May 5;58(2-3):162-9. For unit VII

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BIOINFORMATICS LAB

- 1) Demonstration of BLAST, FASTA and other search engines
- 2) Clustering and contig assembly tool
- 3) Multiple sequence alignment and phylogenetic analysis.
- 4) Gene finder (Prediction)
- 5) Restriction site analysis tools
- 6) Protein visualization tools (RASMOL)

EQUIPMENTS:

1. Computers
2. Internet facility
3. Bioinformatics software

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DOWNSTREAM PROCESSING LABORATORY

Cell disruption techniques.

Solid separation methods-filtration, sedimentation, centrifugation, product enrichment operations, precipitation, ultra filtration, two-phase aqueous extraction, high-resolution purification, preparative liquid chromatographic techniques, product crystallization and drying.

Equipments

1. Tangential flow filtration unit
2. Ultra filtration membrane
3. Centrifuge
4. Chromatographic matrix
5. Chromatographic columns
6. UV-Vis spectrophotometer
7. separating funnels
8. Lyophilizer
9. Magnetic stirrer