School of Biochemical Engineering
Institute of Technology
BANARAS HINDU UNIVERSITY
VARANASI - 221005

SYLLABUS

Proposed Course Structure For Five (5) Year IDD (B.Tech & M.Tech) Course In Biochemical Engineering & Biotechnology

COURSE STRUCTURE:

IDD Part I, Semester I:

Sr. No.	Subjects Theory:	Contact Hours/Week	Credits
1.	Mathematics I	3	3
2.	Physics I	3	3
3.	Chemistry I	3	3
4.	Engineering Mechanics	3	3
5.	Computer Programming & Graphics	4	4
	Practical:		
6.	Physics Lab	3	2
7.	Computer Lab	3	2
8.	Engineering Drawing	4	3
9.	Workshop Practice	3	2
Total for I Semester		**29**	**25**

IDD Part I, Semester II:

Sr. No.	Subjects Theory:	Contact Hours/Week	Credits
1.	Mathematics II	3	3
2.	Physics II	3	3
3.	Chemistry II	3	3
4.	Thermodynamics	3	3
5.	Environmental Studies	4	4
6.	Professional communication	3	3
	Practical:		
7.	Physics Lab	3	2
8.	Chemistry Lab	3	2
9.	Workshop Practice	3	2
Total for II Semester		**28**	**25**
Total for B.Tech. Part I		**57**	**50**

B.Tech Part II, Semester III:

Sr. No.	Subjects Theory:	Contact Hours/Week	Credits
1.	AM 2101: Mathematical Methods	3	3
2.	EC 2113A: Electronics and Instrumentation	3	3
3.	MS 2101: Introduction to Material Science	3	3
4.	CH 2102: Fluid Flow Operations	3	3
5.	BC 2101: Introduction to Modern Biology	4	4
6.	BC 2102: Fundamentals of Biochemistry	3	3
	Practical:		
7.	EE 241A:Electrical Engineering Laboratory	3	2
8.	BC 2301 : Biochemistry and Molecular Biology Laboratory	6	4
Total for Semester III		**28**	**25**

B.Tech Part II, Semester IV:

Sr. No.	Subjects Theory:	Contact Hours/Week	Credits
1.	AM 2201A: Mathematical Methods	3	3
2.	EE 2201A: Electrical Engineering	3	3
3.	ChE 222: Fluid Particle Mechanics & Mechanical Operations	3	3
4.	BC 2201: Fundamentals of Microbiology	4	4
5.	BC 2202: Microbial Biochemistry	4	4
6.	BC 2203: Bioprocess Technology	3	3
	Practical:		
7.	EE 241A: Electrical Engineering Laboratory	3	2
8.	ChE 242: Fluid Flow & Mechanical Operations Laboratory	3	2
9.	BC 2401: Microbiology and Bioprocess Laboratory	3	2
Total for Semester IV		**29**	**26**
Total for B.Tech. Part II		**57**	**51**

B.Tech Part III, Semester V:

Sr. No.	Subjects Theory:	Contact Hours/Week	Credits
1.	BC 3101: Microbial Process Principles	3	3
2.	BC 3102: Enzyme Catalyzed Reaction	3	3
3.	BC 3103: Microbiological Engineering	4	4
4.	BC 3104: Bioprocess calculation	3	3
5.	ChE 314 : Chemical Reaction Engineering - I	3	3
6.	AC 3102: Analytical Techniques in Chemistry	3	3
	Practical:		
7.	BC 3301: Biochemical Engineering Lab	6	4
Total for V Semester		**25**	**23**

B.Tech Part III, Semester VI:

Sr. No.	Subjects **Theory:**	Contact Hours/Week	Credits
1.	BC 3201: Enzyme Engineering and Technology	4	4
2.	BC 3202: Introduction to Molecular Biology	3	3
3.	BC 3203: Bioprocess Instrumentation and Control	4	4
4.	BC 3204: Transport phenomena in Microbial System	3	3
5.	AC 3201: Instrumental Methods of Chemical Analysis	3	3
6.	HU: Open Elective*	3	3
	Practical:		
7.	BC 3401: Enzyme Engineering Laboratory	3	2
8.	BC 3402: Biochemical Engineering Laboratory	6	4
9.	BC 3403: Industrial Visit Report (Viva Voce)	-	2
Total for VI Semester		**28**	**28**
Total for B.Tech Part III		**53**	**51**

*__Any one of the following open electives__

1. HU 321: History of Science and Technology
2. HU 322: Industrial and Organizational Psychology
3. HU 323: Intellectual Property Rights
4. HU 324: Energy management
5. HU 325: Industrial Sociology
6. HU 326: Ethics, Philosophy and Values
7. HU 327: Entrepreneurship Development

B.Tech Part IV, Semester VII:

Sr. No.	Subjects Theory:	Contact Hours/Week	Credits
1.	(UG) BC 4101:Downstream Processing	4	4
2.	(UG) BC 4102: Bioconversion	3	3
3.	(PG) BC 4103:Advanced Fermentation Technology	4	4
4.	(PG) BC 4104: Introduction to Bioinformatics	3	3
5.	(PG) BC 4105: Genetic Engineering	3	3
6.	(PG) ME 4101A:Engineering Economics and Management	3	3
	Practical:		
7.	(PG) BC 4301:Biochemical Engineering Laboratory	3	2
8.	BC 4302:Seminar & Group Discussion	3	2
9.	BC 4303:Industrial Training (Viva-voce)	-	2
Total for VII Semester		**26**	**26**

B.Tech Part IV, Semester VIII:

Sr. No.	Subjects Theory:	Contact Hours/Week	Credits
1.	(UG) BC 4201: Waste water Engineering	3	3
2.	(UG) BC 4202**:** Biosensor Technology	3	3
3.	(PG) BC 4203:Bioreactor Design and Analysis	4	4
4.	(PG) BC 4204:Food Engineering & Biotechnology	4	4
5.	(PG) BC 4205:Bioprocess Plant Design	4	4
6.	(PG) BC 4206:Professional Practices	**-**	2
	Practical:		
7.	BC 4301:Comprehensive viva voce	-	2
8.	(PG) BC 4302:Project-I Dissertation	9	6
9.	(PG) BC 4303:Biochemical Engineering Laboratory	3	2
	Total for VIII Semester	**30**	**30**
	Total for B.Tech. Part IV	**56**	**56**

IDD Part V, Semester IX:

Sr. No.	Subjects Theory:	Contact Hours/Week	Credits
1.	BC 5101:Bio-business planning and management	4	4
2.	*Elective I	3	3
3.	*Elective II	3	3
4.	*Elective III	3	3
5.	PG Open Elective from other Departments	3	3
	Practical:		
6.	BC 5301:Seminar on Dissertation	-	5
7.	BC 5302:Dissertation Interim Evaluation	12	5
	Total for IX Semester	**28**	**26**

IDD Part V, Semester X:

Sr. No.	Subjects	Contact Hours/Week	Credits
1.	BC 5201: Seminar on Dissertation	-	5
2.	BC 5202:Dissertation Evaluation	-	10
3.	BC 5203: PG Seminar	-	2
	Total for X Semester	**-**	**17**
	Total for B.Tech. Part V	**-**	**43**

Year wise Credits

I Year - 50
II Year - 52
III Year - 51
IV Year - 56
V Year - 43

Total Credits = 252

*** Elective I, *Elective II, *Elective III,:- (3 Credit Each) :-**

***Any three of the following**

BC5102: Environmental Biotechnology

BC5103: Regulatory Aspects in Biotechnology (IPR)

BC5104: Modeling and Simulation of Bioprocesses

BC5105 : Cell and Tissue Engineering

BC5106 : Metabolic Engineering

BC5107 : Protein Engineering

BC5108: Animal Cell Biotechnology

BC5109: Plant Biotechnology

BC5110: Recombinant DNA Technology

BC 2101: Introduction to Modern Biology (4)

Concepts of cell biology of living organisms from simple prokaryotes to complex eukaryotes with emphasis on the structural organization of the cell, the function of critical molecular processes that are characteristic of living organisms. The functional organization of cells with particular reference to cell-cell interaction, the structure, function and development of organelles and the biological roles of cellular membranes. Mendelian genetics. Biology of bacterial and archaeal organisms. Prokaryote and eukaryote genome structure and replication; mechanisms of gene expression and regulation. Structure, expression and regulation of prokaryote and eukaryote genes, including DNA replication, transcription and protein synthesis. Introduction to recombinant DNA technology. An introduction to molecular methods used to analyze the structure of genes and genomes Techniques to monitor transcript and protein abundance, protein-protein and DNA-protein interactions. The nature of ecosystems, ecological energetics, biogeochemical cycling, community ecology, introduction to population biology.

Suggested readings:

1) Biology (7th Edition) by Neil A. Campbell and Jane B. Reece
2) Essential Cell Biology, Second Edition by Bruce Alberts, Alexander Johnson, Julian Lewis, and Martin Raff
3) Lehninger Principles of Biochemistry, Fourth Edition by David L. Nelson and Michael M. Cox
4) Schaum's Easy Outline of Biochemistry
5) Microbiology: Third Edition by Jr. Michael J. Pelczar and Roger D. Reid

BC 2102: Fundamentals of Biochemistry (3)

Scope and importance, Structure and function of biomolecules: carbohydrates, lipids, proteins and nucleic acids. Membrane structure and function with emphasis on membrane transport and signaling, Enzymes: characteristics, co-enzymes and ribozymes, kinetics and mechanism of action. Regulation: general concepts. Metabolism: Underlying theoretical principles (thermodynamics, redox reactions, ATP and its role in bioenergetics, control points in metabolic pathways, amplification of control signals, intracellular compartmentation and metabolism, an overview of principles governing catabolism and anabolism.

Suggested readings:

1) Lehninger Principles of Biochemistry, Fourth Edition by David L. Nelson and Michael M. Cox (Hardcover - April 23, 2004)
2) Biochemistry by Jeremy M. Berg, John L. Tymoczko, and Lubert Stryer (Hardcover - May 19, 2006)

3) Lippincott's Illustrated Reviews: Biochemistry (Lippincott's Illustrated Reviews Series) by Pamela C Champe, Richard A Harvey, and Denise R Ferrier
4) Fundamentals of Biochemistry by Donald Voet and Judith G. Voet
5) Schaum's Easy Outline of Biochemistry by Philip W. Kuchel
6) Harper's Illustrated Biochemistry (Harper's Biochemistry) by Robert K. Murray, Darryl K. Granner, Peter A. Mayes, and Victor W. Rodwell
7) Fundamental Laboratory Approaches for Biochemistry and Biotechnology by Alexander J. Ninfa and David P. Ballou

BC 2201: Fundamentals of Microbiology (4)

Introduction- aims and scope; Organisation and function of prokaryotic and eukaryotic cells; Structure and function of cell organelles; Distinguishing features of various groups of microorganisms: actinomycetes, bacteria, molds, yeasts and algae and their broad classification; Isolation, identification and preservation of industrial microorganisms; Physiology and morphology of bacteria, yeast and fungi; Characteristics of viruses; Microbial nutrition and growth principles; Growth measurement techniques; Assimilation of nitrogen and sulphur; Isolation, maintenance long term preservation and improvement of cultures; Anaerobic respiration; Role of microbes in agriculture, public health, medicine and industry.

Suggested Readings:

1) Microbiology: Third Edition by Jr. Michael J. Pelczar and Roger D. Reid
2) Microbiology by Lansing M. Prescott, John P Harley, and Donald A. Klein
3) Microbiology: An Introduction (9th Edition) by Gerard J. Tortora, Berdell R. Funke, and Christine L. Case

BC 2202: Microbial Biochemistry (4)

Structure and function of biomolecules: amino acids, proteins, lipids, nucleotides and nucleic acids; Enzymes-structure and kinetics; Vitamins and coenzymes; Metabolic pathways; Carbohydrate metabolism: glycolysis, pentose phosphate pathway, citric acid cycle; Bioenergetics; Oxidative phosphorylation and photosynthesis; Fatty acid metabolism; Amino acid metabolism; Regulatory mechanisms-feed back inhibition, induction and catabolite repression; Nucleic acids.

Suggested Readings:

1) Lehninger Principles of Biochemistry, Fourth Edition by David L. Nelson and Michael M. Cox

2) Biochemistry by Jeremy M. Berg, John L. Tymoczko, and Lubert Stryer
3) Fundamentals of Biochemistry by Donald Voet and Judith G. Voet
4) Cell and Molecular Biology: Concepts and Experiments by Gerald Karp

BC 2203: Bioprocess Technology (3)

Industrial importance of microorganisms; Substrates for fermentation – major elements, minor elements, vitamins, hormones, trace elements and growth factors; Media design; Alcoholic fermentation – distilled alcohol, wine and beer; Baker's yeast production; Production of glycerol, acetone and butanol; Microbial production of organic acids – citric acid, gluconic acid, itaconic acid, gibberellic acid, lactic acid and vinegar; Production of industrial enzymes – amylases, proteases, invertases, pectinases, cellulases; mushroom production.

Suggested Readings:
1) Fermentation Microbiology and Biotechnology by Mansi El-Mansi and C. F. A. Bryce
2) Principles of Fermentation Technology by P F Stanbury, A. Whitaker, and S. Hall
3) Handbook of Food and Beverage Fermentation Technology (Food Science and Technology) by Stig Friberg
4) Prescott and Dunn's Industrial Microbiology by Gerald Reed
5) Bioprocess Engineering: Basic Concepts (2nd Edition) by Michael L. Shuler and Fikret Kargi

BC 3101: Microbial Process Principles (3)

Introduction; microbial growth phenomenon, different yields - growth, product, ATP, etc., metabolic quotient and maintenance energy. Energetics of the cells. Microbial stoichiometry – substrate and product formation. Mass and energy balances in microbial systems, Thermodynamic aspects of microbial system, First law and second law of thermodynamics in context of microbial systems, Entropy change and its effects on production, Heat exchange in microbial system, Entropy and free energy calculation in microbial system, Comparison of biochemical and chemical operation energetics

Suggested Readings:
1) Biochemical Engineering by Harvey W. Blanch and Douglas S. Clark
2) Biochemical Engineering Fundamentals by James E. Bailey and David F. Ollis
3) Chemical, Biochemical, and Engineering Thermodynamics by Stanley I. Sandler

4) Biochemical Engineering and Biotechnology Handbook by Bernard Atkinson and Ferda Mavituna
5) Biochemical Engineering by Shuichi Aiba, Arthur E. Humphrey and Nancy F. Millos

BC 3102: Enzyme Catalyzed Reaction (3)

Enzyme as biocatalysts; Associated techniques for enzyme applications; Co-immobilization of biocatalysts and cofactor cycling; Enzyme stabilization & protein engineering; Catalytic antibodies; Enzymatic catalysis in bioseparations; Biocatalytic applications in organic synthesis-hydrolytic reactions, oxidation reduction reactions, formation of C-C bond, addition & elimination reactions, glycosyl transfer reactions, isomerization, halogenation / dehalogenation reactions.

Suggested Readings:

1) Enzyme Technology by Ashok Pandey, Colin Webb, Carlos Ricardo Soccol, and Christian Larroche
2) Biocatalysts and Enzyme Technology by Klaus Buchholz, Volker Kasche, and Uwe Theo Bornscheuer
3) Enzyme Technology (Biotechnology Series) by P. Gacesa and J. Hubble
4) Enzyme Technology by Henry Tauber

BC 3103: Microbiological Engineering (4)

Microbial growth; Aerobic and anaerobic growth phenomena; Synchronous culture; Mathematical modeling of microbial growth; Batch, fed-batch and continuous culture cultivation techniques; Substrate utilization and product formation kinetics; Growth and non-growth associated product formation; Aeration and agitation; Principles and mechanism of media sterilization – Thermal and membrane filtration; Batch and continuous sterilization of media; Air sterilization - Principles and design; Characteristics of biological fluids: Rheology of fermentation broth.

Suggested Readings:

1) Biochemical Engineering by Harvey W. Blanch and Douglas S. Clark
2) Biochemical Engineering Fundamentals by James E. Bailey and David F. Ollis
3) Chemical, Biochemical, and Engineering Thermodynamics by Stanley I. Sandler
4) Biochemical Engineering and Biotechnology Handbook by Bernard Atkinson and Ferda Mavituna
5) Biochemical Engineering by Shuichi Aiba, Arthur E. Humphrey and Nancy F. Millos

BC 3104: Bioprocess Calculation (3)

Units and dimensions; Fundamentals of material balance; Balances on unit processes and reactive systems; Behavior of ideal gases: vapor pressure, humidity and saturation; Energy balance; Heat capacity of gases, liquid and solids; Latent heat; Heat of reaction, formation and combustion; Solution and dilution; Energy balance of reactive and non-reactive processes; Stoichiometric relations and yield concepts; Maintenance coefficient; Mass balance based on available electron concept. Unit operations; Rate processes in homogeneous and heterogeneous reactions; Batch and continuous reactors.

Suggested readings:

1) Bioprocess Engineering Principles by Pauline M. Doran
2) Dynamics of Environmental Bioprocesses: Modelling and Simulation by Jonathan B. Snape, Irving J. Dunn, John Ingham
3) Bioreaction Engineering, Bioprocess Monitoring (Bioreaction Engineering) by Karl Schügerl

BC 3201: Enzyme Engineering & Technology (4)

Sources and structure of enzyme; Biosynthesis, regulation and control of enzyme in microorganisms; Kinetics of enzymatic reaction, Single and multiple substrate systems, Inhibition - substrate, product and inhibitors, Analysis of kinetic data, Active and legend binding sites, Mechanism of enzyme action; Large scale production and purification of enzyme; Cofactors and their role in enzyme activity; Immobilization of enzyme and whole cells; Process design and operation strategies for immobilized enzyme reactors; External and diffusional mass transfer limitation, Effectiveness factor and modulus; Stabilization of enzyme, synzyme, Immobilization of multiple enzyme system; Protein engineering; Application of enzyme - Industrial, Analytical and Medical.

Suggested readings:

1) Enzyme Technology by Ashok Pandey, Colin Webb, Carlos Ricardo Soccol, and Christian Larroche
2) Biocatalysts and Enzyme Technology by Klaus Buchholz, Volker Kasche, and Uwe Theo Bornscheuer
3) Enzyme Technology (Biotechnology Series) by P. Gacesa and J. Hubble
4) Enzyme Technology by Henry Tauber

BC 3202: Introduction to Molecular Biology (3)

General concept, introduction to biomolecules, Chromosomes: their structure, replication and recombination. Transcription and gene regulation. Translation, Mutations, Genetics of bacteria and viruses, an overview of genetic engineering / recombinant DNA technology, Nucleic acid manipulations, Gene expression and regulation, signal transduction in response to nutrient, temperature and light and its role. Use of microbes in genetic engineering. Tools for studying DNA / genes, A brief outline of structural and functional genomics, transfectional fermentation process biotechnology

Suggested Readings:

1) Molecular Biology of the Gene, Fifth Edition by James D. Watson, Tania A. Baker, Stephen P. Bell, and Alexander Gann
2) Molecular Biology of the Cell by Bruce Alberts
3) Principles of Genetics by D.Peter Snustad
4) DNA Science: A First Course in Recombinant DNA Technology by David Micklos
5) Cell and Molecular Biology: Concepts and Experiments by Gerald Karp

BC 3203: Bioprocess Instrumentation & Control (4)

Biochemical process variables and their measurements; Control principles and their application in bioreactors; Theory of electrode processes and their applications; Measurement and control of pH, temperature, dissolved oxygen, aeration and agitation, redox potential, foam, etc.; On-line analysis of process parameters; Introduction to biosensors; Transduction principles used in biosensors; Characteristics of biosensors; Biosensors based on amperometric, potentiometric, thermistor FET, fiber optics and bioluminescence; Microbial biosensors; Fundamentals of digital process control; Use of computer in control and optimization of microbiological processes. Artificial neural networking and use in prediction of bioprocess and control

Suggested Readings:

1) Sensors in Bioprocess Control (Biotechnology and Bioprocessing Series) by John Twork
2) Process Control Instrumentation Technology (8th Edition) by Curtis Johnson
3) Instrumentation for Process Measurement and Control, Third Editon by Norman A. Anderson
4) Instrumentation and Control Systems by W. Bolton

BC 3204: Transport Phenomena in Microbial System (3)

Unified theory of momentum, energy and mass transfer; Flow and mixing of Newtonian and non-Newtonian fluids; Gas-liquid mass transfer in microbial systems; Oxygen transfer rates; Single and multiple bubble aeration; Design of spargers and aeration equipment; Mass transfer across free surface as well as freely rising or falling bodies; Basic concept of oxygen transfer coefficient ($K_l a$) and its measurement; Correlation of $K_l a$ with other operating variables; Factors affecting the $K_l a$.

Suggested Reading:

1) Biochemical Engineering by Harvey W. Blanch and Douglas S. Clark
2) Biochemical Engineering Fundamentals by James E. Bailey and David F. Ollis
3) Chemical, Biochemical, and Engineering Thermodynamics by Stanley I. Sandler
4) Biochemical Engineering and Biotechnology Handbook by Bernard Atkinson and Ferda Mavituna
5) Biochemical Engineering by Shuichi Aiba, Arthur E. Humphrey and Nancy F. Millos

BC 4101: Down stream processing (4)

Introduction, Roles of separation process in Industry, Separating agents, steps common to designing and separation process (comparison of feed and product, Rate to be processed, Operating condition (pressure, temperature), Phase equlibria or flux data for membrane, Density, Viscosity, diffusion coefficients, Efficiency or mass transfer data, Complete performance and economic evaluation, complete process design. Different processes / methods of down stream processing viz., centrifugation, distillation, extraction, adsorption, cell disruption, extraction, chromatographic techniques, membrane process and the like.

Suggested Readings:

1) Biochemical Engineering by Harvey W. Blanch and Douglas S. Clark
2) Biochemical Engineering Fundamentals by James E. Bailey and David F. Ollis
3) Biochemical Engineering and Biotechnology Handbook by Bernard Atkinson and Ferda Mavituna
4) Biochemical Engineering by Shuichi Aiba, Arthur E. Humphrey and Nancy F. Millos

5) Downstream Processing of Natural Products: A Practical Handbook by Michael S. Verrall
6) Downstream Processing of Proteins: Methods and Protocols (Methods in Biotechnology) by Mohamed A. Desai
7) Biotreatment, Downstream Processing and Modelling (Advances in Biochemical Engineering / Biotechnology) by P. Bajpai, P.K. Bajpai, D. Dochain, and N.N. Dutta
8) Handbook of Downstream Processing by Inc Staff Routledge Chapman &. Hall and E. Goldberg

BC 4102: Bioconversion (3)

Introduction, definition, objective and scope; Photosynthesis and its primary productivity in nature; Resources, composition and availability of biomass in India; Biomass refining by thermal, chemical and bioconversion systems and their net energy analysis; Environmental effects of biomass refining; Growth, harvesting; processing and utilization of algae and water hyacinth; Integrated bioconversion system approaches.

Suggested Readings:

1) Extractive Bioconversions (Biotechnology and Bioprocessing Series) by B. Mattiasson

2) A Conference on Capturing the Sun through Bioconversion by Bio-Energy Council Staff (Library Binding - 1976)

3) Recent Progress in Bioconversion of Lignocellulosics (Advances in Biochemical Engineering / Biotechnology) by G. T. Tsao

4) Energy from bioconversion of waste materials (Energy technology review) by D. J De Renzo

5) Bioconversion of Cereal Products by B. Godon

BC 4103: Advanced Fermentation Technology (4)

Selection of industrially important cultures; Isolation of pure culture & genetic improvement of industrial microorganisms; Biosynthesis and fermentative production of antibiotics – penicillin, semi-synthetic penicillin, streptomycin, tetracyclines, chloramphenicol; Microbial production of antifungal antibiotics; Metabolic regulations in industrial fermentation; Microbial production of amino acids – lysine, glutamic acid; microbial transformation of steroids; Microbial production of vitamins – ß-carotene, vitamin B_{12}, vitamin B_6; microbiological

assay techniques for estimation of antibiotics and vitamins; Application of antibiotics in/as animal nutrition and food preservation, mycotoxins and microbial insecticides, use of microbes in mineral beneficiation; Production of biodegradable polymers, biofertilizers, microbial exopolysaccharides – xanthan, gellan.

Suggested Readings:

1) Fermentation Microbiology and Biotechnology by Mansi El-Mansi and C. F. A. Bryce
2) Principles of Fermentation Technology by P F Stanbury, A. Whitaker, and S. Hall
3) Handbook of Food and Beverage Fermentation Technology (Food Science and Technology) by Stig Friberg
4) Prescott and Dunn's Industrial Microbiology by Gerald Reed
5) Bioprocess Engineering: Basic Concepts (2nd Edition) by Michael L. Shuler and Fikret Kargi
6) Antibiotics II: Antiobiotics by Fermentation (Japanese Technology Reviews) by Sadao Teshiba

BC 4104: Introduction to Bioinformatics (3)

Introduction to bioinformatics, Operating systems (including Windows and Unix), Networks - including the Intranets and the Internet, Experimental sources of biological data, Publicly available databases, High throughput sequencing, Experimental determination of protein structures, Gene expression monitoring, Proteomics, Metabolomics, Acquisition of chemical information - including molecular structures - from databases, Visualization of molecules, Simulation of molecular interactions, Introduction to industry-standard modeling software (Clustal V, Clustal W, RasMol, Oligo, Molscript, treeview, Alscript, Genetic analysis software), Basic algorithms for sequence alignment, Visualization of sequence data, Sequence alignment, Homology searching - including BLAST and other query searches , Gene expression informatics, Introduction to gene finding and automated prediction, gene arrays, Visualization of sequence data, Drug discovery, Genetic basis of disease, Personalized medicine and gene-based diagnostics, Legal, ethical and commercial ramifications of bioinformatics.

Suggested Readings:

1) Essential Bioinformatics by Jin Xiong
2) Bioinformatics for Dummies by Jean-Michel Claverie and Cedric Notredame
3) An Introduction to Bioinformatics Algorithms (Computational Molecular Biology) by Neil C. Jones and Pavel A. Pevzner
4) Bioinformatics: Sequence and Genome Analysis by David W. Mount

5) Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins by Andreas D. Baxevanis and B. F. Francis Ouellette

BC 4105: Genetic Engineering (3)

Introduction to gene, Plasmids, Construction of vectors, Transpososn, joining of DNA molecules, Restriction enzymes and their use in gene manipulation, Gene transfer technologies- Protoplast Fusion methods, gene transfer using cloning vector, electroporation techniques, Microinjection method, Biolistic method for DNA transfer, Microinjection method, Use of liposome for gene transfer, Transformation, Transduction, Conjugation, Transfection, Site directed mutagenesis, Cloning strategies, Recombinant selection and characterization, DNA sequencing, gene identification by chromosome walking and jumping, cloning of insulin gene and other genes of commercial interest, strain improvement of industrially important organisms, Synthesis of gene, Antisense therapy, Finger printing of DNA, PCR and oligonucleotide synthesis, gene chip and micro array, cDNA Library.

Suggested Readings:

1) Molecular Biology of the Gene, Fifth Edition by James D. Watson, Tania A. Baker, Stephen P. Bell, and Alexander Gann
2) Molecular Biology of the Cell by Bruce Alberts
3) Principles of Genetics by D.Peter Snustad
4) DNA Science: A First Course in Recombinant DNA Technology by David Micklos
5) Cell and Molecular Biology: Concepts and Experiments by Gerald Karp
6) Gene VIII
7) Recombinant DNA Technology: Concepts and Biomedical Applications (Ellis Horwood Books in the Biological Sciences) by Jerry Guyden, Mark Steinberg, and David Calhoun
8) Recombinant DNA Technology by O.S. Reddi
9) Recombinant DNA Technology and Applications by Alex Prokop, Rakesh K. Bajpai, and Chester S. Ho

BC 4201: Waste Water Engineering (3)

Definition of waste; Physical, chemical and biological characteristics of waste water; BOD, COD and TOD - their estimation and correlation; BOD progression curve and kinetics; Determination of BOD; Effect of reaction rate constant on short term BOD; Determination of BOD rate constants, Kinetics of nitrification and denitrification; Treatment process for waste water; Kinetics of activated sludge process (ASP); Mixing regime in ASP; Aeration system; Loading criteria; Sludge

viability; Solid-liquid separation; Primary and secondary clarifier; Anaerobic treatment of wastes; Kinetics of anaerobic treatment; Sludge characteristics; Process modeling and control; Waste water minimization, Case studies.

Suggested readings:

1) Handbook of Water and Wastewater Microbiology by Duncan Mara and Nigel J. Horan
2) Waste Water Technology: Origin, Collection, Treatment and Analysis of Waste Water by W. Fresenius
3) Biotechnology of Waste Treatment and Exploitation (Ellis Harwood Series in Water and Waste Water Technology) by J. M. Sidwick and R. S. Holdom

BC 4202: Biosensor Technology (3)

Measurements and instrumentation principles; Fundamentals of transducers and sensors, their sensitivity, specificity and linearity. Introduction to biosensors; Transduction principles used in biosensors; Bio-component of the sensors; Biosensors based on amperometric, potentiometric, thermistor devices, FET, fiber optics, bioluminescence; Microbial biosensors; Applications**.**

Suggested Readings:

1) Biosensor Technology by Buck
2) Food Biosensor Analysis (Food Science and Technology) by Wagner
3) Biosensors: Theory and Applications by Donald G. Buerk
4) Biosensor Principles and Applications (Biotechnology and Bioprocessing Series) by Blum

BC 4203: Bioreactor Design and Analysis (4)

Thermodynamics and rate concept of biological systems; Bioreactor configuration - batch, continuous stirred-tank, tubular, plug flow, packed bed, air lift, fluidized bed and the like; Kinetic expression; Monod's equation and its generalization; Bioreactor design calculation; Bioreactor design and optimum operations – Mixing characteristics; Residence time distribution in bioreactors and non ideality, Concentration distribution and Temperature distribution; Analysis of multiple interacting microbial populations, Biological system parameters; Processes involving microbial flocs; Bioreactors containing microbial films; Basic concept of scale-up of bioreactors.

Suggested Readings:

1) Biochemical Engineering by Harvey W. Blanch and Douglas S. Clark
2) Biochemical Engineering Fundamentals by James E. Bailey and David F. Ollis

3) Biochemical Engineering and Biotechnology Handbook by Bernard Atkinson and Ferda Mavituna
4) Biochemical Engineering by Shuichi Aiba, Arthur E. Humphrey and Nancy F. Millos
5) Bioreactor System Design (Biotechnology and Bioprocessing Series) by Juan A. Asenjo

BC 4204: Food Engineering & Biotechnology (4)

General introduction of food and food preservation, Composition of foods, chemistry, properties, and function of carbohydrates, proteins, amino acids, lipids, vitamins. General principles underlying spoilage and chemical changes of food caused by microorganisms. Food preservation by application of heat (canning), dehydration, freezing, ionization radiation, chemical preservatives, fermentation and the like. Case studies of food processing viz. meat, fish and poultry; vegetables and fruits; bakery and dairy products. Quality control of food and food products. Food laws, rules and standards, food engineering overview, Production of engineered food products, Case studies in food engineering, Industrial and commercial aspects of food technology.

Suggested Readings:
1) Understanding Food Science and Technology (with InfoTrac) by Peter Murano
2) Handbook of Food and Beverage Fermentation Technology (Food Science and Technology) by Stig Friberg
3) Prescott and Dunn's Industrial Microbiology by Gerald Reed
4) Bioprocess Engineering: Basic Concepts (2nd Edition) by Michael L. Shuler and Fikret Kargi

BC 4205: Bioprocess Plant Design (4)

Introduction; General design information; Mass and energy balance; Flow sheeting; Piping and instrumentation; Materials of construction for bioprocess plants; Mechanical design of process equipment; Vessels for biotechnology application; Design of bioreactors; Design considerations for maintaining sterility of process streams processing equipment; Selection and specification of equipment for handling fluids and solids; Selection, specification design of heat and mass transfer equipment used in bioprocess industries; Design of facilities for cleaning of process equipment used in biochemical industries; Utilities for biotechnology production plants; Process economics; Bioprocess validation; Safety Considerations; Case studies

Suggested Reading:

1) Bioreactor System Design (Biotechnology and Bioprocessing Series) by Juan A. Asenjo
2) Biochemical Engineering by Harvey W. Blanch and Douglas S. Clark
3) Biochemical Engineering Fundamentals by James E. Bailey and David F. Ollis
4) Biochemical Engineering and Biotechnology Handbook by Bernard Atkinson and Ferda Mavituna
5) Biochemical Engineering by Shuichi Aiba, Arthur E. Humphrey and Nancy F. Millos

BC 4206: Professional Practices (2)

Overview of the state of the art of technology and management practices in the industry presented by senior professionals. The course will consist of several invited lectures based on case studies of different biotechnological industries. The students will be feeded with several tutorials, group discussions, home assignments, term papers etc. and evaluated.

BC 5101: Bio-business planning and management (4)

Economic, social and environmental benefits of modern biotechnology; Resource base for bioprocess industries; Typical stages in commercialization of biotechnology processes / products; Financial appraisal of biotechnology projects.

Trips agreement; IPR issues in relation to biotechnology products/processes; Architecture of a typical patent application; Alternative models of technology transfer and licensing; Funding mechanisms of commercial projects; Bio safety principles; Bio ethics.

Suggested Reading:

1) Environmental Biotechnology and Cleaner Bioprocesses by Gloria Sanchez and Elizabeth Hernandez
2) TRIPS agreement
3) GATT and India
4) Our Postwar Society - A Long-term View - IPR Education Economics Democracy by Arnold J Zurcher
5) Intellectual Property Rights in Agricultural Biotechnology (Biotechnology in Agriculture Series, 28) by F. H. Erbisch and K. M. Maredia
6) Genetically Modified Foods: Debating Biotechnology (Contemporary Issues Series) by Michael Ruse and David Castle

[*]Elective I, [*]Elective II, [*]Elective III,:- (3 Credit Each) :-
***Any three of the following**

BC 5102: Environmental Biotechnology

Components of environment; Environmental pollutions, its measurements and management; Air pollution and its control through biotechnology; Water pollution and its control; Microbiology of waste water treatment – Aerobic and anaerobic processes, Treatment scheme for domestic and industrial waste water; Microbial degradation of Xenobiotics compounds; Pesticides and pest management through biological processes; Solid wastes and management; Bioremediation of contaminated soils and waste land; Global environmental problems – Ozone depletion, Green house effect, Acid rain and Global warming, their impact and biotechnological approaches for management; Environmental acts and regulations.

Suggested Reading:

1) Introduction to Environmental Technology (Preserving the Legacy) by Ann Boyce
2) Prentice Hall's Environmental Technology Series, Volume III: Health Effects of Hazardous Materials by Neal K. Ostler, Thomas A. Byrne, and Michael Malachowski
3) Basic Environmental Technology: Water Supply, Waste Management, and Pollution Control by Jerry A. Nathanson

BC 5103: Regulatory Aspects in Biotechnology (IPR)

Introduction to IP (Intellectual Property), Copyright, Related Rights, Trademarks, Geographical Indications Industrial Design, Patents, WIPO Treaties, Protection of New Varieties of Plants and Unfair Competition. The nature of plant breeder's rights systems. International framework for the protection of IP, Dynamic nature of biotechnology and IP, Legal requirements and administrative steps for getting a patent for a biotechnological invention, databases & search of technical and patent information, Drafting of Patents. Interpretation and evaluation of the effect of a patent document. IP as a factor in a research and development, Negotiation of research contracts with commercial partners, management and practical use of IP rights, including licensing and enforcement. Ethical aspects and its relation with intellectual rights

Suggested Readings:

1) TRIPS agreement
2) GATT and India

3) Our Postwar Society - A Long-term View - IPR Education Economics Democracy by Arnold J Zurcher
4) Intellectual Property Rights in Agricultural Biotechnology (Biotechnology in Agriculture Series, 28) by F. H. Erbisch and K. M. Maredia
5) Genetically Modified Foods: Debating Biotechnology (Contemporary Issues Series) by Michael Ruse and David Castle

BC 5104: Modeling and Simulation of Bioprocesses

Types of kinetic models; Data smoothing and analysis; Mathematical representation of bioprocess; Parameter estimation; Numerical Integration techniques; Parameter sensitivity analysis; Statistical validity; Discrimination between two models; Physiological state markers and its use in the formulation of a structured model; Development of compartment and metabolic pathway models for intracellular state estimation; Dynamic simulation of batch, fed-batch steady and transient culture metabolism; Numerical optimization of bioprocesses using mathematical models.

Suggested Reading:
1) Bioreactor System Design (Biotechnology and Bioprocessing Series) by Juan A. Asenjo
2) Biochemical Engineering by Harvey W. Blanch and Douglas S. Clark
3) Biochemical Engineering Fundamentals by James E. Bailey and David F. Ollis
4) Biochemical Engineering and Biotechnology Handbook by Bernard Atkinson and Ferda Mavituna
5) Biochemical Engineering by Shuichi Aiba, Arthur E. Humphrey and Nancy F. Millos

BC 5105: Cell and Tissue Engineering

Tissue engineering principles, Biological Cells, Importance and Properties of Scaffolds and Signals and its types. Quantitative analysis and Morphometric investigation of a living cell system. Protein Synthesis in Tissue Engineering, Stem cell biology- embryonic and adult stem cell, Mesenchymal cells, Mechanobiology, Fundamentals of Construct technology, Biomaterials/ Biopolymers for scaffolds and architecture and Production Techniques, Cardiovascular tissue engineering, Bioreactors, Orthopedic tissue engineering, BMP and Chondriocytes, Implants. Methods of cell delivery and cell encapsulation. Physiological measurements and medical imaging.

Suggested Readings:

1) Molecular Biology of the Gene, Fifth Edition by James D. Watson, Tania A. Baker, Stephen P. Bell, and Alexander Gann
2) Molecular Biology of the Cell by Bruce Alberts
3) Culture of Cells for Tissue Engineering (Culture of Specialized Cells) by Gordana Vunjak-Novakovic and R. Ian Freshney
4) Cell and Molecular Biology: Concepts and Experiments by Gerald Karp
5) Gene VIII
6) Recombinant DNA Technology: Concepts and Biomedical Applications (Ellis Horwood Books in the Biological Sciences) by Jerry Guyden, Mark Steinberg, and David Calhoun
7) Recombinant DNA Technology by O.S. Reddi
8) Recombinant DNA Technology and Applications by Alex Prokop, Rakesh K. Bajpai, and Chester S. Ho

BC 5106: Metabolic Engineering

Importance of metabolic engineering, comprehensive models for cellular reactions, stoichiometry of cellular reactions, reaction rates, dynamic mass balance, yield coefficients and linear rate equations, the black box model, elementary balance, heat balance, identification of gross measurement errors, regulation of enzyme activity, control of transcription initiation, control of translation, regulation at the whole cell level, branch point classification, enhancement of product yield and productivity, extension of substrate range, extension of product spectrum and novel products, improvement of cellular properties, metabolic pathways synthesis algorithm, case study- lysine biosynthesis, restriction on the maximum yield, theory, sensitivity analysis, direct flux determination from transient intensity measurements, metabolic isotopic steady state experiments. distribution of TCA cycle metabolite isotopomers forms labeled pyruvate and acetate, interpretation of experimental data, carbon metabolite balances by use of atom mapping matrices, metabolic flux analysis of lysine biosynthesis, network in *C.glutamicum*, metabolic flux analysis of specific deletion mutants of *C.glutamicum*, determination of intracellular fluxes, application of flux analysis to the design of cell culture media.

Suggested Readings :

1) Biochemical Engineering by Harvey W. Blanch and Douglas S. Clark
2) Biochemical Engineering Fundamentals by James E. Bailey and David F. Ollis
3) Biochemical Engineering and Biotechnology Handbook by Bernard Atkinson and Ferda Mavituna
4) Biochemical Engineering by Shuichi Aiba, Arthur E. Humphrey and Nancy F. Millos

5) Downstream Processing of Proteins: Methods and Protocols (Methods in Biotechnology) by Mohamed A. Desai
6) Biotreatment, Downstream Processing and Modelling (Advances in Biochemical Engineering / Biotechnology) by P. Bajpai, P.K. Bajpai, D. Dochain, and N.N. Dutta
7) Handbook of Downstream Processing by Inc Staff Routledge Chapman &. Hall and E. Goldberg
8) Pathway Analysis and Optimization in Metabolic Engineering by Néstor V. Torres and Eberhard O. Voit
9) Metabolic Engineering: Principles and Methodologies by Gregory N. Stephanopoulos, Aristos A. Aristidou, and Jens Nielsen

BC 5107: Protein Engineering

Dynamics and Structural Evolution Protein Engineering: Study of molecular interaction forces (Hydrogen, Ionic, covalent, van- der walls and others) ,Structure and chemical properties of the building blocks of biological materials (amino acids, sugars, nucleic acids); Protein structure and folding; Mechanism of folding; Principles of protein secondary structures, alpha-helix, beta-helix, beta-sheet, beta-turns, random coils, coiled coils, and others and case studies with Keratin, collagen and green fluorescence protein. Methods and tools used to characterize the molecular structures of biological materials(Circular dichroism, NMR, X-ray diffraction, FTIR, scanning electron microscopy and others), Protein dynamics, Protein Folding (1^0,2^0,3^0 & 4^0), Proteins design and engineering, Random and site directed mutagenesis; Strategies to alter catalytic efficiency; structure prediction and modeling proteins; Molecular graphics in protein engineering; Dynamics and mechanics; Signal transduction; Receptors and hormones; antigen-antibody relationship; Drug-protein interactions and Design applications of engineered proteins. Molecular chaperons, Heat shock protein, case study of misfolded prions; Drugs-protein interactions and Design; Protein engineering benefits in industry and medicine; Engineering of antibodies.

Suggested Readings:

1) Protein Engineering: Principles and Practice by Jeffrey L. Cleland and Charles S. Craik
2) Engineering the Genetic Code: Expanding the Amino Acid Repertoire for the Design of Novel Proteins by Nediljko Budisa
3) Lehninger Principles of Biochemistry, Fourth Edition by David L. Nelson and Michael M. Cox
4) Protein Engineering For Industrial Biotechnology by Lilia Alberghina
5) Molecular Biology of the Cell by Bruce Alberts

BC 5108: Animal Cell Biotechnology

Animal cell metabolism; Regulation and nutritional requirement; Animal cell growth characteristics and kinetics; Nutrient, substrate and product transport through mammalian cell; Micro-carrier attached growth; Cell culture in continuous, perfusion and hollow-fiber reactor; Mass transfer in mammalian cell culture; Scale-up of cell culture processes; Case studies.

Suggested readings

1) Molecular Biology of the Cell by Bruce Alberts
2) Bioreactor System Design (Biotechnology and Bioprocessing Series) by Juan A. Asenjo
3) Biochemical Engineering by Harvey W. Blanch and Douglas S. Clark
4) Biochemical Engineering Fundamentals by James E. Bailey and David F. Ollis
5) Biochemical Engineering and Biotechnology Handbook by Bernard Atkinson and Ferda Mavituna
6) Culture of Cells for Tissue Engineering (Culture of Specialized Cells) by Gordana Vunjak-Novakovic and R. Ian Freshney
7) Culture of Animal Cells: A Manual of Basic Technique by R. Ian Freshney

BC 5109: Plant Biotechnology

Special features and organization of plant cells; Totipotency; Regeneration of plants; Examples of regeneration from leaves, roots, stem etc; Plant products of industrial importance; Biochemistry of major metabolic pathways and products; Cell suspension culture development; Characterization, kinetics of growth, product formation and examples; Large scale production of secondary metabolites from suspension cultures-nutrient optimization, cell growth regulators , biological and technological barriers; Mutation; Somaclonal variation; Genetic engineering of plant cells; Plant cell reactors - types of reactors, comparison of reactor performance; Immobilized plant cell reactors; Novel design concepts.

Suggested Readings:

1) Plant Biotechnology: The Genetic Manipulation of Plants by Adrian Slater, Nigel W. Scott, and Mark R. Fowler
2) Plant Biotechnology: Current and Future Applications of Genetically Modified Crops
3) Introduction to Plant Biotechnology by H. S. Chawla
4) Plant Biotechnology and Developmentseries: Current Topics in Plant Molecular Biology

5) Plant Biotechnology and Transgenic Plants (Books in Soils, Plants, and the Environment, 92) by Kirsi-Marja Oksman-Caldentey and Wolfgang H. Barz

BC 5110: Recombinant DNA Technology

Introduction to r-DNA technology; Vectors: definition and types; Construction and properties of plasmid, phage, cosmid and phagemid vectors; Restriction enzymes and other enzymes-properties and uses in cloning; Gene cloning-genomic and c-DNA cloning, chromosome walking; Expression of genes in recombinant cells; Stability of recombinant cells in the production of biochemicals; Restriction mapping, DNA sequencing; Gene mapping; polymerase chain reaction.

Suggested Readings:

1) Molecular Biology of the Gene, Fifth Edition by James D. Watson, Tania A. Baker, Stephen P. Bell, and Alexander Gann
2) Molecular Biology of the Cell by Bruce Alberts
3) Culture of Cells for Tissue Engineering (Culture of Specialized Cells) by Gordana Vunjak-Novakovic and R. Ian Freshney
4) Cell and Molecular Biology: Concepts and Experiments by Gerald Karp
5) Gene VIII
6) Recombinant DNA Technology: Concepts and Biomedical Applications (Ellis Horwood Books in the Biological Sciences) by Jerry Guyden, Mark Steinberg, and David Calhoun
7) Recombinant DNA Technology by O.S. Reddi
8) Recombinant DNA Technology and Applications by Alex Prokop, Rakesh K. Bajpai, and Chester S. Ho