NORTH-EASTERN HILL UNIVERSITY
DEPARTMENT OF BIOTECHNOLOGY & BIOINFORMATICS
SHILLONG -- 22

M.Sc. BIOTECHNOLOGY SYLLABUS

(Choice Based Credit System)

Total Credit 72 Marks 1800 // Core Credit 60 Marks 1500 // Each Open Credit 6 Marks 150

I[st] Semester

Course No.	*Course Title*	*Marks*	*Credit*
BIT C 101	Cell Biology & Genetics	100	4
BIT C 102	Biomolecules	100	4
BIT C 103	Microbiology	100	4
BIT C 104	Laboratory ï I	150	6

II[nd] Semester

BIT C 201	Molecular Biology	100	4
BIT C 202	Immunology	100	4
BIT C 203	Laboratory ï II	100	4
BIT O 204	**Microbial Technology**	**100**	**4**
BIT O 205	**Laboratory Work**	**50**	**2**

III[rd] Semester

BIT C 301	Computer applications, Bio-informatics & Biostatistics	100	4
BIT C 302	Genetic Engineering & Plant Biotechnology	100	4
BIT C 303	Laboratory ï III	50	2
BIT C RP	Research Project (IIIrd & IV Semester)	(Assigned in 3rd Semester & assessed in 4th Semester)	
BIT O 304	**Applied Molecular Genetics**	**100**	**4**
BIT O 305	**Laboratory Work (Molecular Genetics)**	**50**	**2**
BIT O 306	**Bioinformatics in Molecular and Cell Biology**	**100**	**4**
BIT O 307	**Laboratory Work (Bioinformatics)**	**50**	**2**

IV[th] Semester

BIT C 401	Animal Cell Science & Basic Enzymology	100	4
BIT C 402	Bioprocess Engineering & Technology	100	4
BIT C 403	Environmental Biotechnology	100	4
BIT C 404	Laboratory IV	100	4
BIT C RP	Research Project (Continue from 3rd semester)	100	4
	Total	**1500**	**60 Core**
		300	**12 Open**

Each lecture is for 90 mins.
For Core Courses the Laboratory is for 4 days in a week for 3hr duration each.
For Open Courses the Laboratory is for 2 days in a week for 3hr duration

Project: Project will be based upon research and actual bench work. It will begin from IIIrd semester and will continue through the IVth semester. Project report will be submitted at the end of IVth semester and evaluated.

Student Seminar: Each student under the supervision of a faculty member will deliver a comprehensive seminar, which will be evaluated. The topic normally will be from an emerging area of Modern Biology, Biomedical, Biotechnology or its applications.

Laboratory I,II,III,IV: Independent practicals may be held under each course. However, for examination purposes a single comprehensive 2-3 days practical be held for each semester, covering different courses offered during that semester.

Invited lectures from Eminent Researchers, Industrialists and others, on recent issues related to Biodiversity, Ethics, Biosafety, Intellectual Property Rights and Patent Issues and Good laboratory and manufacturing practices will be organized.

Ist Semester

BIT C 101 CELL BIOLOGY AND GENETICS Credit 4
(Theory)

Unit-1

Cell theory, Structure of prokaryotic and eukaryotic cells; Cellular organelles:
Structural organization of Plasma membrane, cell wall, Mitochondria; Chloroplast and Nucleus. Cell motility-cilia, flagella of eukaryotes and prokaryotes. Cell cycle: molecular events and model systems.
Cellular responses to environmental signals in plants and animals: mechanisms of signal transduction (Rhizobium legume symbiosis, steroids, protein/peptides).

Unit-2

Transport of nutrients, ions and macromolecules across membranes. Cellular energy transactions- role of mitochondria and chloroplast.
Extranuclear Inheritance: Genomes of mitochondria and chloroplast, Mitochondrial genetic defects; Genetic Systems of Yeast and *Neurospora*

Unit 3

Genome size and evolutionary complexity; Microbial genetics: bacterial chromosomes and plasmids, conjugation, transduction and transformation in bacteria. Bacteriophages and their genetic systems. Lytic and lysogenic phases of λ phage. Genetic recombination and its molecular mechanism

Unit 4

Human genetics: The human chromosome, chromosome abnormalities, Mendelian pedigree pattern, Hardy-Weinberg equilibrium, genotype and allelic frequencies; Inborn-errors of metabolism, polygenic and multifactorial inheritance; Sex-determination, role of Y-chromosome, sex chromosome anomalies; Instability of the genome: Mutation-types, chromosomal aberrations, gene mutation, molecular basis of mutation,

Suggested readings

1. Molecular Biology of Cell, Alberts B et al. Garland Publishers, (2001)
2. Molecular Cell Biology, Lodish et al. Scientific American Books (1995)
3. Principles of cell and Molecular Biology, Kleinsmith LJ & Kish VM, Harper Collins College Publishers (1995).
4. Cell and Molecular Biology, Karp G, John Wiley and Sons. (1999).
5. Molecular Biology, Friedfelder D, Jones and Bartlett Publication, (1998).
6. Principles of Genetics, Gardner EJ and Sunstad DP, John Wiley and Sons, (2000).
7. Genetics, Strickburger MW, Macmillan Pub. Co., (1994).
8. Human Molecular Genetics, Strachan T and Read AP, Garland Science, (2004).

BIT C 102 **BIOMOLECULES** **Credit 4**

(Theory)

Unit-1

Chemical foundations of Biology: pH, pK, Henderson-Hesselbalch equation, acids, bases, buffers, weak bonds, covalent bonds.
Quantitative Bioenergetics: Principles of thermodynamics, Gibbs energy changes, redox reactions, equilibrium constants, concentration gradients, photons.

Unit-2

Classes of organic compounds and functional groups: Amino acids and peptides: classification, chemical reactions and physical properties. Sugars: classification and reactions; types, structural features, methods for compositional analysis.
Heterocyclic compounds and secondary metabolites in living systems: nucleotides, pigments, isoprenoids, alkaloids, flavanoids, phenols. Lipids: classification, structure and functions.

Unit-3

Conformational properties of polynucleotides, polysaccharides and proteins: structural features and their analysis; Protein folding: biophysical and cellular aspects. Glyco and lipoproteins: structure and function. Protein-protein and protein-ligand interactions, physical and chemical methods for study.

Unit-4

Separation techniques for different biomolecules: chromatography, electrophoresis, electrofocussing, centrifugation. Proteins: separation and purification and criteria of homogeneity, Ramachandran map. Physical techniques in protein, nucleic acids and polysaccharide structural analysis: UV, LASER Raman Spectroscope, MASS Spectroscopy, Fluorescence Spectroscopy. Physical and chemical methods for immobilization of biomolecules. Nucleic acid hybridization.

Suggested readings

1. Essentials of Molecular Biology, David Friefilder, Jones and Barllett Publications, (2003).
2. Proteins-Structure and Molecular Properties, TE Creighton, WH Freeman and company (2002).
3. Genes VIII, B. Lewin, Oxford University Press, (2003).
4. Harperôs Biochemistry, Murray RK et al., Prentice Hall International (1999).
5. Physical Chemistry of Macromolecules, Tanford, C., John Wiley and Sons, (1998).
6. Lehninger Principle of Biochemistry, Nelson DL and Cox MM, Worth Publishers, (2000).
7. Biochemistry, Stryer I., H.Freeman and Company, (2000).

BIT C 103 **MICROBIOLOGY** **Credit 4**
(Theory)

Unit-1

Introduction of microbiology and microbes, controversy over spontaneous generation, role of microorganisms in transformation of organic matter and in the causation of diseases;

Principles of -microbial nutrition; Construction of culture media; Enrichment culture techniques for isolation of nutritional categories. Microbial Growth: growth curve, Synchronous growth; Continuous culture; Influence of environmental factors on Growth; Culture collection and maintenance of cultures.

Unit-2

Metabolic diversity among microorganisms: Photosynthesis; Chemolithotrophy; Hydrogen-iron-nitrite-oxidizing bacteria; Nitrate and sulfate reduction; Methanogenesis and acetogenesis; Fermentations-diversity, Nitrogen metabolism .
Microbial Diversity: Bacteria: Purple and green bacteria, cyanobacteria, acetic acid bacteria, Pseudomonads, lactic and propionic acid bacteria, endospore forming rods and cocci; Mycobacteria and Mycoplasms. *Archaea*: Halophiles; Methanogens; Hyperthermophilic archaea; Thermoplasma. *Eukarya*: Algae, Fungi, Slime molds and Protozoa.

Unit-3

Discovery, Classification and structure of viruses; Lysogeny; DNA viruses; RNA viruses; Replication; Viroids and Prions .
Microbial Diseases: Disease reservoirs; Infectious disease transmission; Respiratory infections caused by bacteria and viruses; Tuberculosis; Sexually transmitted diseases including AIDS; Diseases transmitted by animals, insects and ticks, food and water borne diseases; Pathogenic fungi; Emerging and resurgent infectious diseases.

Unit-4

Host-Parasite Relationships: Normal microflora of skin, oral cavity, Gastrointestinal tract; Entry of pathogens into the host; colonization and factors predisposing to infections; types of toxins and their structure; Mode of actions; Virulence and Pathogenesis.
Chemotherapy/Antibiotics: Antimicrobial agents; Sulfa drugs; Antibiotics: Penicillins and Cephalosporins; Broad-spectrum antibiotics; Antibiotics from prokaryotes; Antifungal antibiotics; Mode of action; Resistance to antibiotics.

Suggested readings

1. General Microbiology, Stainer, RY, Ingraham, JL, Wheelis, ML., and Painter, PR. The Macmillan Press Ltd., (2000).
2. Principles of Microbiology, Atlas RM, Mosby, (1995).
3. Microbiology, Davis BD et al., Harper and Row, (1990).
4. Microbiology-Principles and exploration, Black JG, Prentice Hall, (1999).
5. Microbial Biotechnology, Glazer AN, Nikaido H, WH Freeman and Company, (1995).

BIT C 104 **LABORATORY 1** **Credit 6**

(Practicals)

1. Microscopy: Bright field, Phase Contrast & Fluorescence microscopy.
2. Sub-cellular fractionation; mitochondrion & chloroplast and their characteristic activities.
3. Study of metaphase chromosomes from mouse/rat bone marrow/root tip.
4. Study of meiosis from grasshopper testes/flower bud.
5. Lymphocyte culture and preparation of chromosomes from human.
6. Study of sister chromatid exchanges and chromosomal aberrations.
7. Preparation of human karyotype.
8. Quantitative reactions of amino acids, sugars, lipids, proteins and nucleic acids.
9. Separation of DNA fragments by Agarose Gel Electrophoresis.
10. Growth curve; Effect of temperature, pH and carbon and nitrogen sources on growth.
11. Microscopic examination of bacteria, yeast and molds and study of organisms by Gram stain, acid fast stain and staining of spores.
12. Assay of antibiotics and demonstration of antibiotic resistance.
13. Isolation and maintenance of organisms by plating, streaking and serial dilution methods.

Suggested readings

1. Principles of Genetics, Gardner EJ and Snustad DP, John Wiley and Sons, (2000).
2. Principles and Techniques of Practical Biochemistry, Wilson K and Walker J, Cambridge Univ Press, (1994).
3. Human Molecular Genetics, Strachan T and Read AP, Garland Science, (2004).
4. An introduction to Practical Biochemistry, Plummer DT, Tata McGraw Hill, (1987).
5. Principles of Microbiology, Atlas RM, Mosby, (1995).

IInd Semester

BIT C 201 **MOLECULAR BIOLOGY** **Credit 4**
(Theory)

Unit 1

Structure of DNA and its physico-chemical properties.
Prokaryotic and eukaryotic DNA replication- DNA polymerases and proteins involved in DNA synthesis and their specific roles. Structure and properties of RNA polymerases in prokaryotes and eukaryotes. General and specific transcription factors, Mechanism of transcription and post transcriptional modifications of RNAs, RNA editing.

Unit 2

Features of genetic code, amino-acyl synthases and charging of t-RNA, prokaryotic and eukaryotic translation, regulation of translation. Synthesis of secretary and membrane proteins, import into nucleus, mitochondria, chloroplast and peroxisomes.

Unit 3

Regulation of gene expression: prokaryotic gene expression with reference to inducible and repressible operons. Concept of eukaryotic gene regulation. Genetic basis of pattern formation in *Drosophila*, homeotic loci.
DNA and RNA tumour viruse; oncogenes, tumour suppressor genes and their mechanism of action. Antisense RNA and RNA interference. Applications of antisense and ribozyme technologies

Unit 4

Importance of genome projects, human genome project, Sequence component of eukaryotic genome, satellite, microsatellite and minisatellite DNA; physical mapping by building clone contigs, genomic libraries, YAC, BAC libraries. General organization of human genome. An overview of gene expression in human cells, genetic markers, principles and strategies in identifying disease genes, application of sequence information for identification of defective genes.

Suggested readings

1. Molecular Cloning: a laboratory manual, Sambrook J., Fritsch EF. and Maniatis T, Cold Spring harbor Laboratory Press, (2000)
2. Introduction to Practical Molecular Biology, DEabre P, John Wiley & Sons Ltd, (1998).
3. Molecular Biology Labfax, T.A. Brown (Ed.), Bios Scientific Publishers Ltd. (1991)
4. Molecular Biology of the Gene, Watson JD., Hopkins NH., Roberts JW., Steitz JA and Weiner AM (The Benjamin/Cummings Publ.Co.), (1996).
5. Molecular Cell Biology, Darnell J, Lodish H and Baltimore D, Scientific American Books, USA, (2000)
6. Molecular Biology of the Cell, Alberts B., Bray D, Lewis J., Ralf M., Roberts K. and Watson J.D., Garland Publishing Inc. (2001)
7. Gene IX, Lewin B, Oxford University Press, (2005).

BIT C 202 **IMMUNOLOGY** **Credit 4**
(Theory)

Unit 1

Basic concepts in immunology, cells of immune system, innate and acquired immunity, clonal nature of immune response; Organization and structure of lymphoid organs, lymphocyte trafficking; Nature and biology of antigens, T- dependent, T-independent and superantigens.

Unit-2

Antibody structure and function, antigen-antibody interactions; Major Histocompatibility complex, MHC gene organizations, Class I and Class II MHC molecules: structure and functions; B-cell receptor and T-cell receptor, generation of diversity; Complement system; Transplantation, graft vs host reaction, mixed lymphocyte reaction.

Unit-3

Regulation of immune system: Antigen processing and presentation to T-cells, activation of B- and T-lymphocytes; Cytokines and their role in immune regulation, T-cell regulation, MHC restriction; Immunological tolerance, immunomodulation.

Unit 4

Hypersensitivity: types, features and mechanism of immediate and delayed hypersensitivity reactions; immunity to microbes (protozoa, bacteria, fungi, intracellular parasites, helminthes & viruses); Immune to tumor; AIDS and immunodeficiencies. Hybridoma technology and monoclonal antibodies; Vaccine: natural, synthetic &genetic, problem and prospect associated with development of vaccine for diseases like AIDS, Cancer and Malaria.

Suggested Readings

1. Molecular biology of the Cell, Alberts B., Bray D., Lewis J., Ralf M., Roberts K. and Watson J.D., Garland Publishing Inc. (2001).
2. Kuby Immunology, Goldsby R.A., Kindt Thomas J., Osbarne B.A., WH Freeman & Company, (2000).
3. Immunology-Understanding the Immune System Elgert K.D, Wiley Liss, (1996).
4. Roittôs essential Immunology, Roitt I.M. and Delves P.J., Blackwell Science Ltd., (2001).
5. Immunology 6th Edition, Roitt I., Brostoff J. and Male D., Mosby Harcourt Publishers, (2001).

BIT C 203 **LABORATORY-II** **Credit 4**

(Practicals)

1. Extraction of genomic DNA and RNA
2. Study of semiconservative replication in mammalian cells.
3. PCR amplification of genomic DNA.
4. Gel electrophoresis of the PCR-product.
5. Restriction endonuclease digestion of DNA.
6. Separation of mononuclear cells by Histopaque.
7. Isolation and identification of macrophages.
8. Differential WBC count.
9. Raising of antiserum in mouse/rabbit and immunodiffusion studies in agar gels.
10. Antigen-antibody interactions in vitro-double immunodiffusion
11. ELISA

Suggested readings

1. Molecular Cloning: a laboratory manual, Sambrook J., Fritsch EF. and Maniatis T, Cold Spring harbor Laboratory Press, (2000)
2. Practical Biochemistry, Plummer L, Tata McGraw-Hill, (1990).
3. Biochemistry, Stryer I., H.Freeman and Company, (2000).
4. Roittôs essential Immunology, Roitt IM and Delves PJ, Blackwell Science Ltd., (2001).
5. Immunology 6th Edition, Roitt I, Brostoff J. and Male D, Mosby Harcourt Publishers, (2001).

BIT O 204 **Microbial Technology** **Credit 4**

(Theory)

Unit I

Microbial genetics: Replication, regulation of bacterial gene expression, mutations, genetic transfer, role of bacteria in cancer, DNA amplification using PCR ï manipulation of gene expression in prokaryotes ,ï increasing protein production ï expression and application in E. coil.

Unit 2

Nature of microbial polysaccharides, mechanism of synthesis; microbial transformation of steroids and sterols: screening for microbial products; microorganism for waste treatment; Immobilization of microalgae for pollutant removal.
Bioprocess technology, beer brewing, cheese manufacture, moldï modified foods, Wine, Vinegar, The fermentation process , procedure and equipments.

Unit 3

Microbial production of amino acids, antibiotics, microbial enzymes, organic acids; methods for laboratory fermentations, isolation of fermentation products, immobilized microbial cells and fine chemicals. Strain improvement, culture preservation and inoculum development. Elementary principles of microbial reaction engineering, Microbial culture selection, fermented foods, probiotics.

Unit 4

Microbes in agribiotechnology (livestock and transgenic plants); Introduction to bio-insecticides, candidate microbiology insecticides; biofertilizers, inoculant manufacture; diagnostic clinical microbiology (emerging and re-emerging infectious diseases, microscopy, culture & sensitivity); microbes in production of alternative energy; microbial endophytes and novel metabolites; patenting.

Suggested Readings

1. General Microbiology, Stainer RY, Ingraham JL, Wheelis ML. & Painter PR. The Macmillan Press Ltd., (2000).
2. Microbiology-Principles and exploration, Black JG, Prentice Hall, (1999).
3. Microbial Biotechnology, Glazer AN, Nikaido H, WH Freeman and Company, (1995).
4. Biochemical Engineering Fundamentals (2^{nd} ed), JE Baily & DF Ollis, McGraw Hill Book Co. New York. 1986
5. Bioprocess Technology: Fundamentals and Applications, KTH, Stockholm. 2000
6. Bioprocess Engineering: Basic Concepts (2^{nd}ed), ML Shuler, & F Kargi, Prentice Hall, Engelwood Cliffs. 2003
7. Principles of Fermentation Technology (2^{nd} edition), PF Stanbury, A Whittaker and SJ Hall, Pergamon Press, Oxford. 1995

BIT O 205 **Microbial Technology** **Credit 2**

(Laboratory Work)

1. Microbial population enumeration techniques
2. Biochemical identification of unknown bacteria
3. Nucleic acid and plasmid isolation
4. PCR and Electrophoresis
5. Microbial Production of citric acid and antibiotics.

Suggested Readings

1. Microbiology-Principles and exploration, Black JG, Prentice Hall, (1999).
2. Microbeal Biotechnology, Glazer AN, Nikaido H, WH Freeman and Company, (1995).

III[rd] Semester

BIT C 301

COMPUTER APPLICATIONS, BIOINFORMATICS & BIOSTATISTICS **Credit 4**

(Theory)

Unit 1

Introduction of computer networks- Topologies and designs; Basics of computer operating systems-windows and Linux; Introduction to Markup language-Hyper Text Markup Language (HTML) and Extensive Markup Language (XML); Spreadsheets and Presentation software.

Unit-2

Introduction to internet and its application. Introduction to bioinformatics; Databse concepts, biological databases. Information retrieval from biological databases. Sequence alignment and database searching-BLAST and FASTA. Pairwise and Multiple sequence alignment. Profiles, motifs and features identification.

Unit-3

Phylogenetic analysis. Extraction of a phylogenetic data set. Tree building methods: Tree evaluation. Comparative genome analysis. Reconstruction of metabolic pathways. Computational tools for expression analysis. Application of bioinformatics in drug designing.

Unit-4

Brief description and tabulation of data and its graphical representation. Measures of central tendency and dispersion: mean, median, mode, range, standard deviation, variance. Idea of two types of errors and level of significance. Tests of significance (F & t test); Chi-square tests. Simple linear regression and correlation.

Suggested readings

1. Bioinformatics: A practical guide to the analysis of genes and proteins. Baxevanis A.D and Ovellette B.F.F., Wiley-Interscience, (2002).
2. Molecular and Biotechnology. A comprehensive desk reference, R.A. Meyes (Ed.) VCH Publishers Inc. (1995)
3. Textbook of Bioctechnology Das H.K., Wiley Dreamtech India Pvt Ltd, (2004).
4. Principles of Genome analysis and genomics, Primrose SB, Twyman RM, Blackwell Science (2002).
5. Biostatistics-A foundation for Health Science, Daniel WW, John Wiley (1983).
6. Statistical Methods, Medhi J, Willey Eastern Limited, (1992).

BIT C 302

GENETIC ENGINEERING AND PLANT BIOTECHNOLOGY (Theory) **Credit 4**

Unit 1

Molecular tools and their applications: Restriction enzymes, modification enzymes, production of defined DNA fragments, Gene cloning vectors and their use in various systems; Gene cloning strategies- insertion of DNA molecule into a vector; the use of reverse- transcriptase, cDNA and RT-PCR; Detection of recombinant molecules, library construction and screening.

Unit 2

Study of gene regulation, DNA transfection, S1 mapping, RNase protection assay, reporter assay; Expression strategies for heterologous genes-in bacteria, in yeast, in mammalian cells and in plants. Site directed mutagenesis and knockout mutations, targeted gene replacement. High throughput genome sequencing, Functional proteomics and genomics- Yeast and *Arabidopsis*.

Unit 3

Different culture methods and regeneration protocols for plants; production of haploids, Plant hormones and their role in development; embryo culture and embryo rescue technique; Artificial seeds; protoplast culture and fusion; regeneration of hybrid plants; symmetric and asymmetric hybrids, cybrids, cryopreservation, slow growth and DNA banks for germplasm conservation. Role of DNA markers with special emphasis on RFLPs, linkage analysis, RAPD markers, STS, EST, microsatellites, SCAR (sequence characterized amplified regions), SSCP(single strand conformational polymorphism), AFLP, map based cloning.

Unit 4

Transgenic organisms- vector and transformation in plants; transformation of monocots, transgene stability and gene silencing, chloroplast transformation; Application of plant transformation for productivity and performance: abiotic stress, use of ACC synthase, polygalacturanase, ACC oxidase, male sterile lines, bar and barnase system, terminator technology. Application of plant transformation for productivity, performance and resistance to insects, nematodes, virus, RIP, coat protein mediated, disease resistance, PR proteins Biosafety guidelines, IPR and ethical issues in biotechnology.

Suggested readings

1. Molecular Cloning: a Laboratory Manual, J Sambrook, E F Fritsch and T Maniatis, Cold Spring Harbor Laboratory Press, New York, 2000.
2. Methods in Enzymology Vol.152, Guide to Molecular Cloning Techniques, SL Berger and AR Kimmel, Academic Press, Inc. San Diego, 1998.
3. Molecular Biotechnology (2nd Edn.) S B Primrose, Blackwell Scientific Publishers, Oxford, 1994.
4. Route Maps in Gene Technology, M R Walker and R Rapley, Blackwell Science Ltd, Oxford, 1997.
5. Genetic Engineering, An Introduction to gene analysis & exploitation in eukaryotes, SM Kingsman and A J Kingsman, Blackwell Scientific Publications, Oxford, 1998.
6. Plant Biotechnology: J. Hammond, P. McGarvey and V Yusibov (Eds):, Springer Verlag, 2000
7. Plant Cell and Tissue Culture for the Production of Food Ingredients: T-J, Fu, G. Singh, and W R Curtis (Eds.):, Kluwer Academic/Plenum Press. 1999.
8. Elements of Biotechnology: P K Gupta, Rastogi and Co. Meerut, 2007.
9. An Introduction to Plant Tissue Culture: M K Razdan. Tata Mc Graw Hill Publishing Co. Ltd. 2004

BIT C 303 **LABORATORY-III** **Credit 4**

Practicals

1. Isolation of plasmid DNA
2. DNA amplification using polymerase chain reaction in plant system.
3. Agarose gel electrophoresis and restriction digestion of DNA.
4. Preparation of competent cells and Bacterial transformation
5. Callus propagation and organogenesis.
6. Anther culture.
7. Computer applications and Bioinformatics (Biological database search).
8. Statistical analysis of biological data.

Suggested readings

1. Molecular Cloning: a Laboratory Manual, J Sambrook, E F Fritsch and T Maniatis, Cold Spring Harbor Laboratory Press, New York, 2000.
2. DNA Cloning: a Practical Approach, D M Glover and B D Hames, IRL Press, Oxford 1995.
3. Plant Cell and Tissue Culture for the Production of Food Ingredients: TJ Fu, G. Singh and W R Curtis (Eds.), Kluwer Academic/Plenum Press. 1999.
4. Practical Biochemistry, Plummer L, Tata McGraw-Hill, (1990).
5. Bioinformatics: A practical guide to the analysis of genes and proteins. Baxevanis A.D and Ovellette B.F.F., Wiley-Interscience, (2002).
6. Molecular and Biotechnology. A comprehensive desk reference, R.A. Meyes (Ed.) VCH Publishers Inc. (1995)

BIT O 304 **Applied Molecular Genetics** **Credit 4**

Theory

Unit 1

Protein-DNA interaction, regulation of transcription and translation, gene silencing in plants and animals; Chromosome engineering, targeted gene replacement, Gene therapy.
Molecular diagnosis of cancer, Oncogenes and tumor suppressor genes; Apoptosis, cell cycle controls and cancer.

Unit 2

Genes in development- Gene expression and body pattern formation (Fruiting body in *Dictyostellium, Vulva* formation in Caenorhabditis, Hox gene and body patterning in vertebrates); Recent advances in developmental genetics and potential applications, prenatal diagnosis; Regulation of root, shoot and flower development, seed formation.

Unit 3

Genetic disorders of Hemoglobin; Diseases due to mutations in different classes of proteins, enzyme defects, disorders of structural proteins, neurodegenerative disorders; Identifying human disease genes; Application of RFLP in forensic and disease prognosis; Genetic basis of plant-pathogen interactions, R genes mediated disease resistance

Unit 4

Genome projects in model organisms: Yeast, *C elegans, Arabidopsis* and rice genome projects, organization of human genome; Instability of the genome: Mutation-types, chromosomal aberrations, gene mutation, molecular basis of mutation, polymorphism, DNA damage and mechanism of DNA repair; Application of Molecular cytogenetic techniques: Chromosome banding, chromosome FISH and GISH, chromosome painting and CGH- analysis.

Suggested readings

1. Genetics in Medicine, Thompson and Thompson, Saunders, (2004).
2. Genetics: Analysis of genes and genomes, Hartl DA & Jones EW, Jones & Bartlett Publ., (2000).
3. Molecular biology of the cell, Alberts B, Johnson A, Lewis J, Raff M, Roberts K, Walter P., Garland Science, (2002).
4. Gene IX, Lewin B, John Wiley and Sons, (2006).
5. Human Molecular Genetics, Strachan T and Read AP, Garland Science, (2004).
6. Biochemistry & Molecular Biology of Plants, Buchanan BB,Gruissen W & Jones RL, ASPP (2000).
7. Molecular Cloning: a Laboratory Manual, J Sambrook, E F Fritsch and T Maniatis, Cold Spring Harbor Laboratory Press, New York, 2000.

BIT O 305 **Applied Molecular Genetics** **Credit 2**

Laboratory Work

1. PCR amplification of genomic DNA.
2. Reverse-transcription ï polymerase chain reaction.
3. Western Blot of regulatory protein of cell cycle / apoptosis.
4. Preparation of metaphase chromosomes from cultured lymphocytes and cell lines.
5. Genetic fidelity of tissue culture plants with RAPD markers.

Suggested readings

1. Human Molecular Genetics, Strachan T and Read AP, Garland Science, (2004).
2. Biochemistry & Molecular Biology of Plants, Buchanan BB,Gruissen W & Jones RL, ASPP (2000).
3. Molecular Cloning: a Laboratory Manual, J Sambrook, E F Fritsch and T Maniatis, Cold Spring Harbor Laboratory Press, New York, 2000.

BIT O 306 **Bioinformatics in Molecular and Cell Biology** **Credit 4**

Theory

Unit-1

Database concepts, Introduction to internet and its application, Introduction to bioinformatics, Protein and nucleotide databases, Information retrieval from biological databases, Sequence alignment and database searching-similarity searches using BLAST and FASTA.

Unit 2

Molecular biology concept- Molecular markers (SNPs, VNTRs, 23SrRNA), Study of gene expression by Microarray, Transcriptome, Expressed Sequence Tags (ESTs); regulation of transcription.
Sequence alignment-Pairwise, Multiple, local and global alignments, substitution, Insertions and deletions in a sequence, statistical significance of alignments ;Gene structure prediction-CENSOR, ReapetMasker; detection of functional sites in DNA sequences-PromoterScan and GenScan.

Unit 3

Substitution Scoring Matrices (PAM and BLOSUM) for protein sequences; Pattern and domain databases-PROSITE, BLOCKS, PRINTS; motifs and profiles; Biomolecular interaction-DNA - protein and protein- ligand interactions.

Unit 4

Protein structure-X-ray crystallography, The protein databank and the PDBSum-SCOP, CATH,DALI and HSSP ;Visualisation of molecular structures-RasMol and Pymol; Protein secondary structure prediction, Fold Recognition; Transmembrane topology prediction.

Suggested readings

1. Bioinformatics: A practical guide to the analysis of genes and proteins. Baxevanis A.D and Ovellette B.F.F., Wiley-Interscience, (2002).
2. Molecular and Biotechnology. A comprehensive desk reference, R.A. Meyes (Ed.) VCH Publishers Inc. (1995)
3. Textbook of Bioctechnology Das H.K., Wiley Dreamtech India Pvt Ltd, (2004).
4. Principles of Genome analysis and genomics, Primrose SB, Twyman RM, Blackwell Science (2002).
5. Human Molecular Genetics, Strachan T and Read AP, Garland Science, (2004).

BIT O 307 **Bioinformatics in Molecular and Cell Biology** **Credit 2**

Practicals

1. Retrieval of protein and nucleotide sequences from suitable databanks
2. Similarity searches using BLAST and FASTA
3. Online tools for PCR primer generation and restriction analysis
4. Visualization of genome maps-usage of Mapviewer from NCBI resource

Suggested readings

1. Bioinformatics: A practical guide to the analysis of genes and proteins. Baxevanis A.D and Ovellette B.F.F., Wiley-Interscience, (2002).
2. Molecular and Biotechnology. A comprehensive desk reference, R.A. Meyes (Ed.) VCH Publishers Inc. (1995)
3. Principles of Genome analysis and genomics, Primrose SB, Twyman RM, Blackwell Science (2002).

IVth Semester

BIT C 401 ANIMAL CELL SCIENCE AND BASIC ENZYMOLOGY Credit 4 (Theory)

Unit 1:

Structure and organization of animal cell; Primary and established cell lines; Brief discussion on the chemical, physical and metabolic functions of different constituents of culture medium; Role of carbon dioxide, serum and supplements; Serum & protein free defined media and their application. Basic techniques of mammalian cell culture *in vitro*, maintenance of cell culture; Cell synchronization. Measuring parameters of growth in cultured cells; Measurement of cell viability and cytotoxicity.

Unit 2:

Organ and histotypic cultures; Scaling-up of animal cell culture; Cell cloning and micromanipulation, cell transformation; Application of animal cell culture; Cell culture based vaccines. Stem cell cultures- embryonic stem cells and their applications, three dimensional culture and tissue engineering
Somatic cell genetics- interspecific somatic cell genetics and its application in human chromosome mapping. Concept of system biology- basic approaches in computational biology relating to digestive, respiratory, nervous and circulatory systems.

Unit 3:

Enzymes: enzyme properties, classification, denaturation; Energetics of enzyme catalyzed reactions, transition state; Mechanism of enzyme action; Regulation of enzyme activity; Iso-enzymes, co-factors and co-enzyme.

Unit 4:

Enzyme kinetics: Michaelis-Menten equation and its derivatives, significance of Vmax and Kcat, enzyme inhibitions; kinetics and thermodynamic analysis, effects of organic solvents on enzyme catalysis and structural consequences. Ribozymes and Catalytic antibodies. Multienzyme systems: Occurrence, polygemic nature of multienzyme systems.

Suggested readings

1. Culture of Animal Cells: A Manual of Basic Techniques (5th Edition): R Ian Freshney. Wiley-Liss, 2005
2. Animal Cell Culture ï Practical Approach, Ed . John R W Masters. Oxford Univ Press. 2000
3. Fundamentals of Enzymology: Nicoles C Price and Lewis Stevens. Oxford Univ. Press. 2005.
4. Animal Cell Culture Techniques, Ed Martin Clynes, Springer. 1998
5. Review on Medical physiology (21st Ed.), Ganong, Lang Medical Publisher, 2003.
6. S. Wrightôs Applied physiology (13 Ed.), Keel et al., Oxford Press, 1989.
7. Lehninger Principle of Biochemistry, Nelson DL and Cox MM, Worth Publishers, (2000).
8. Biochemistry, Stryer I., H.Freeman and Company, (2000).

BIT C 402 BIOPROCESS ENGINEERING & TECHNOLOGY Credit 4
(Theory)

Unit 1

Isolation, preservation and maintenance of industrial microorganisms, kinetics of microbial growth and death, product decomposition, effect of environmental conditions.
Bioreactors; Media for industrial fermentation, types of fermentation processes; Analysis of batch, Fed-batch and continuous bioreactions, stability of microbial reactors, analysis of mixed microbial populations, specialized bioreactors (pulsed, fluidized, photobioreactors etc.).

Unit 2

Measurement and control of bioprocess parameters, basic principles of feedback control, proportional, integral and derivative control; Downstream Processing: introduction, removal of microbial cells and solid matter, foam preparation, precipitation, filtration, centrifugation, cell disruptions, liquid-liquid extraction, chromatography, membrane process, drying and crystallization.

Unit 3

Enzyme and cell immobilization and their industrial applications; Use of microbes in mineral beneficiation and oil recovery; Industrial production of chemicals: Alcohol (ethanol), acids (citric, acetic and gluconic), solvents (glycerol, acetone, butanol), antibiotics (penicillin, streptomycin, tetracycline), amino acids (lysine, glutamic acid). Effluent treatment: DOC and COD treatment and disposal of effluents.

Unit 4

Introduction to Food Technology- elementary idea of canning and packing, sterilization and Pasteurization, technology of typical Food/Food products (bread, cheese, idli), food preservation, fermented foods and probiotics.

Suggested readings

1. Biochemical Engineering, S Aiba, AE Humphrey and NF Millis, Academic Press. New York 1973
2. Biochemical Reactors, B Atkinson, Pion Ltd., London. 1974
3. Biochemical Engineering Fundamentals (2nd edition), JE Baily and DF Ollis, McGraw Hill Book Co. New York. 1986
4. Bioprocess Technology: Fundamentals and Applications, KTH, Stockholm. 2000
5. Process Engineering in Biotechnology, A T Jackson, Prentice Hall, Engelwood Cliffs. 1991
6. Bioprocess Engineering: Basic Concepts (2nd edition), ML Shuler, and F Kargi, Prentice Hall, Engelwood Cliffs. 2003
7. Principles of Fermentation Technology (2nd edition), PF Stanbury, A Whittaker and SJ Hall, Pergamon Press, Oxford. 1995
8. Bioreaction Engineering Principles, J Nielson, and J Villadsen, Plenum Press.1994
9. Chemical Engineering Problems in Biotechnology, M L Shuler, (Ed) AICE. 1989
10. Biochemical Engineering, J M Lee, Prentice Hall Inc. 1991

BIT C 403 ENVIRONMENTAL BIOTECHNOLOGY Credit 4

(Theory)

Unit 1

Limiting factors, energy transfer and biogeochemical cycling in ecological systems; Response of microbes, plant and animals to environmental stresses; Concept of ecosystems and ecosystem management, Environmental problems- ozone depletion, green house effect, water, air and soil pollution, land degradation.

Unit 2

GEMs in environment; Role of environmental biotechnology in management of environmental problems, Bioremediation, advantages and disadvantages; In situ and ex-situ bioremediation; slurry bioremediation; Bioremediation of contaminated ground water and phytoremediation of soil metals; microbiology of degradation of xenobiotics

Unit 3

Sewage and waste water treatment and solid waste management, chemical measure of water pollution, conventional biological treatment, role of microphyte and macrophytes in water treatment; Recent approaches to biological waste water treatment, composting process and techniques, use of composted materials.

Unit 4

Biofuels and biological control of air pollution, plant derived fuels, biogas, landfill gas, bioethanol, biohydrogen; use of biological techniques in controlling air pollution; Removal of chlorinated hydrocarbons from air.

Suggested readings

1. Wastewater Engineering ï Treatment, Disposal and Reuse, Metcalf and Eddy. Inc. Tata McGraw Hill, New Delhi. 1991
2. Environmental Science (5^{th} Edition) by WP Cunninghum & BW Saigo., Mc Graw Hill. 1999.
3. Introduction to Biodeterioration , D Allsopp and K J Seal, ELBS/Edward Arnold. Cambridge Univ Press. 2004.
4. Biotechnology for Wastewater Treatment. P Nicholas Cheremisinoff. Prentice Hall Of India. 2001
5. Biotechnological Methods of Pollution Control. SA Abbasi and E Ramaswami. Universities Press 1999
6. Environmental Biotechnology, Concepts and Applications. Hans-Joachin Jordening and Josef Winter. Winter-VCH. 2005
7. Biology of wastewater Treatment. N F Gray. Mc Graw Hill . 2004.
8. Fundamentals of ecology (5^{th} Edition) by EP Odum and GW Barrett, Thomson Books/Cole, 2005.
9. An Introduction to Environmental Biotechnology by Milton Wain Wright. Kluwar Acad Publ. Group, Springer, 1999.

BIT C 404 **LABORATORY-IV** **Credit 4**

Practicals

1. Trypsinization of monolayer and subculturing.
2. Cryopreservation and thawing of cell lines.
3. Preparation of metaphase chromosomes from cultured cells.
4. Isolation of industrially important microorganisms.
5. Determination of thermal death point (TDP) and thermal death time (TDT) of microorganism for design of a sterilizer.
6. Determination of Km and Vmax of urease/arginase activity by M.M and L.B. plots, respectively.
7. Determination of Ki of urease/arginase activity by M.M and L.B. plots, respectively.
8. (a) Determination of growth curve of a given microorganism and also determines substrate degradation profile.
   (b) Compute specific growth rate (m), growth yield (Yx/s) from the above.
9. Comparative studies of Ethanol production using different substrates.
10. Production and assay of Alkaline Protease.
11. Detection of coliforms for determination of the purity of potable water.
12. Determination of dissolved oxygen concentration of water sample by Winklerôs method.
13. Determination of biological oxygen demand (BOD) of sewage sample.
14. Determination of chemical oxygen demand (COD) of sewage sample.
15. Test for the degradation of a aromatic hydrocarbons by bacteria.
16. Estimation of nitrate in drinking water.
17. Submission of Field / study tour report (compulsory; visit some biotechnology department, institute and industrial firms)

Suggested readings

1. Principles of Fermentation Technology (2^{nd} edition), PF Stanbury, A Whittaker and SJ Hall, Pergamon Press, Oxford. 1995
2. Wastewater Engineering ï Treatment, Disposal and Reuse, Metcalf and Eddy. Inc. Tata McGraw Hill, New Delhi. 1991
3. Microbial Biotechnology, Principles and Applications Lee Yuan Kun (Ed). World Scientific. 2003.
4. Molecular Cloning: a Laboratory Manual, J Sambrook, E F Fritsch and T Maniatis, Cold Spring Harbor Laboratory Press, New York, 2000.
5. Culture of Animal Cells: A Manual of Basic Techniques (5^{th} Edition): R Ian Freshney. Wiley-Liss, 2005
6. Animal Cell Culture ï Practical Approach, Ed . John R W Masters. Oxford Univ Press. 2000.