NORTH-EASTERN HILL UNIVESITY, SHILLONG
M.Sc. Biotechnology Postgraduate (PG) Programme

First Semester

Paper Code	Name of the Paper	Credits (Theory)	Credits (Practical)	Total Credits	Marks
BIT-CC-500	Cell Biology and Genetics	3	1	4	100
BIT-CC-501	Microbiology	3	1	4	100
BIT-DSEC-502	Biomolecules / *MOOC 1*	3	1	4	100
BIT-DSEC-503	Fundamentals of Bioinformatics / *MOOC* 2	3	1	4	100
BIT-GEC-504	Biostatistics	4		4	100
Total				**20**	**500**

Second Semester

Paper Code	Name of the Paper	Credits (Theory)	Credits (Practical)	Total Credits	Marks
BIT-CC-505	Molecular Biology	3	1	4	100
BIT-CC-506	Immunology	3	1	4	100
BIT-DSEC-507	Microbial Technology / *MOOC 3*	3	1	4	100
BIT-DSEC-508	Advanced Bioinformatics / *MOOC 4*	3	1	4	100
BIT-RM-509	Research Methodology & Project Writing	4		4	100
BIT-SEC-510	Laboratory Skills in Biotechnology	3	1	4	100
Total				**24**	**600**

Third Semester

Paper Code	Name of the Paper	Credits (Theory)	Credits (Practical)	Total Credits	Marks
BIT-CC-600	Applied Molecular Genetics	3	1	4	100
BIT-CC-601	Animal Biotechnology	3	1	4	100
BIT-CC-602	Plant Biotechnology	3	1	4	100
BIT-DSEC-603	Bioprocess Engineering and Enzymology */MOOC 5*	3	1	4	100
BIT-DSEC-604	Environmental Biotechnology, IPR and Bioentrepreneurship, / *MOOC 6*	3	1	4	100
BIT-DSEC-605	Genetic Engineering and Biosafety/ *MOOC 7*	4		4	100
Total				**24**	**600**

Fourth Semester

Paper Code	Paper	Credit	No. of Papers	Total Credits
BIT-DSEC-606	Dissertation		1	20
	Problem Identification, Review of Literature, Proposal Writing and Presentation. Dissertation: Experiments, Data Collection and Analysis and Discussion	16		
	Dissertation Presentation and Viva	4		
Total		**20**	**1**	**20**

- **Paper Code:** CC- Core Course; DSEC-Discipline Specific Elective Course; GEC-Generic Elective Course; RM-Research Methodology; SEC- Skill Enhancement Course.
- **MOOC 1/ MOOC 2/ MOOC 3/ MOOC 4/ MOOC 5/ MOOC 6/ MOOC 7**: Massive Online Open Courses that can be opted in lieu of DSEC to a maximum of 8 credits per semester.

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Paper Credit	**Marks**	**Type of Evaluation**	**Per Cent**
4	End Semester Evaluation	**External**	**75%**
	Sessional Evaluation	**Internal**	**25%**

Note:
Sessional Evaluation Marks: The average of the best two tests/seminars/Field Work marks will be considered out of three tests/seminars/Field Work. At least, 1 test is compulsory except for paper 606.

FIRST SEMESTER

BIT-CC-500 CELL BIOLOGY AND GENETICS Credit 4

Course Objectives:
CO1: Give the fundamental concepts of various aspects of cell biology and genetics.
CO2: Learn the basic techniques and protocols of cell biology and genetics.

Learning Outcomes: On successful completion of this course, student are expected to learn the following
LO1: Identify key components that constitute living cells and understand the functions of different organelles.
LO2: Basic understanding of the classical concepts of Mendel's genetics and the genetic differences between prokaryotes and eukaryotes
LO3: Analyse hereditary data and apply fundamental coupling analyses and genetic calculations.
LO4: Learn the fundamental cytology aspects to be performed in the laboratory.
LO5: Solve problems based on genetics and its analysis.

Theory Credit 3

Unit l
Structure and function of cell organelles: Plasma membrane- transport of nutrients, ions and macromolecules; Cell walls; Cell motility; Mitochondria- Electron Transport Chain and Oxidative Phosphorylation; Chloroplasts- Chlorophyll and photophosphorylation, Transport across mitochondria and chloroplasts; Golgi complex; Endoplasmic reticulum; Ribosomes, Lysosomes, Peroxisomes (functions); Nucleus- DNA and other components of chromatin, nucleolus, nuclear envelope and transport. Cell cycle and its molecular events, Cell division, Cell renewal, Cell signalling- Signal transduction in animal and plant cells (Rhizobium legume symbiosis, steroids and protein/peptides).

Unit 2
Microbial genetics: bacterial chromosomes and plasmids. Conjugation, transduction and transformation in bacteria. Bacteriophages and their genetic systems. Lytic and lysogenic decision of λ phage. Genetic recombination and heteroduplex DNA. Extranuclear Inheritance, genomes of mitochondria and chloroplast, mitochondrial genetic defects.

Unit 3
Historical background, Principles of Mendelian genetics, Mendel's experiments, Rediscovery of Mendel's work, Chromosomal theory of inheritance, Crossing-over, Linkage analysis and Genetic maps, Inborn error of metabolism, Hardy-Weinberg equilibrium, genotype and allele frequencies, Molecular basis of inheritance, Sex determination: role of Y chromosome, mechanism and sex chromosome abnormalities, Mutation: concept, types, molecular mechanism and consequences. Cancer genetics.

Unit 4 (Practical) Credit 1
1. Sub-cellular fractionation; mitochondrion & chloroplast
2. Study of metaphase chromosomes from mouse/rat bone marrow/root tip.
3. Study of meiosis from grasshopper testes/flower bud.
4. Preparation of human karyotype from metaphase

Suggested Readings:

1. Becker's World of the Cell, Global Edition Paperback (2017) 9th ed. Hardin J, Bertoni G, Kleinsmith L, Pearson Publication, ISBN: 9781292177694
2. Essential Cell Biology (2019) 5th ed. Alberts B, Hapkin K, Johnson A, Morgan D, Raff M, Roberts K, Water P, WW Norton & Co Publication, ISBN: 0393680371.
3. Karp's Cell and Molecular Biology (2019) 9th ed. Karp g, Iwasa J, Marshall W, John Wiley & Sons, ISBN: 978-1-119-59816-9
4. Principles of Genetics (2006) 8th ed. Gardner EJ, Simmons, MJ and Snustad DP, John Wiley &Sons Inc, ISBN: 8126510439.
5. Essentials of Genetics (2015) 9th ed. William S, Michael K, Cummings R, Spencer, CA and Palladino MA, Prentice Hall Internationals, ISBN-10: 0134047796
6. Genetics (2017) 9th ed. Daniel L. Hartal & B. Cochrane, ISBN: 128412293X
7. Introduction to Quantitative Genetics (1995) Falconer DS, and Mackay TFC, ISBN: 0582243025.
8. Evolution 4th ed. (2017) D. Futuma and M. Kirkpatrick, ISBN: 9781605356051
9. An Introduction to Genetic Analysis (2015) Griffith AJFJ, Wessler SR, Carroll SV and Doebley J, ISBN: 0-7167-3520-2.
10. Principles of Genetics, Gardner EJ and Snustad DP, John Wiley and Sons,(2000).
11. Human Molecular Genetics, Strachan T and Read AP, Garland Science,(2004).
12. An introduction to Practical Biochemistry, Plummer DT, Tata McGraw Hill, (1987).

BIT-CC-501 **MICROBIOLOGY** **Credit 4**

Course Objectives:

CO1: Students will be introduced to the field of microbiology with special emphasis on microbial diversity, morphology, physiology and nutrition; methods for control of microbes and host-microbe interactions.

CO2 : Students will be provided with practical skills in basic microbiological techniques

Learning Outcomes: On successful completion of this course, student are expected to learn the following

LO1: Identify major categories of microorganisms and analyze their classification, diversity, and ubiquity

LO2: Identify and demonstrate structural, physiological, genetic similarities and differences of major categories of microorganisms

LO3: Identify and demonstrate how to control microbial growth

LO4: Demonstrate and evaluate interactions between microbes, hosts and environment

LO5: Isolate, characterize and identify common bacterial and fungal organisms, determine microbial load, and preserve cultures.

Theory **Credit 3**

Unit 1

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; Nitrogen metabolism.

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.

Unit 3

Discovery, Classification and structure of viruses; Lysogeny; DNA viruses; RNA viruses; Replication; Viroids and Prions; methods of cultivation of viruses, maintenance and handling.

Microbial Diseases: Disease reservoirs; Infectious disease transmission; Pathogenic fungi ; Emerging and resurgent infectious diseases.

Antimicrobial agents; Sulfa drugs; Antibiotics: Penicillins and Cephalosporins; Broad-spectrum antibiotics; Antifungal agents; Mode of action; Resistance to antibiotics

Unit 4 (Practical) **Credit 1**

1. Sterilization, disinfection and safety procedures in microbiological laboratory.
2. Preparation of media and isolation of bacteria in pure culture by streak plate method.
3. Preparation of bacterial smear and Gram's staining.
4. Enumeration of bacteria: standard plate count.

5. Antimicrobial sensitivity test and demonstration of drug resistance.
6. Maintenance of stock cultures: slants, stabs and glycerol stock cultures
7. Determination of phenol co-efficient of antimicrobial agents.
8. Determination of Minimum Inhibitory Concentration (MIC)
9. Study of bacterial growth curve

Suggested Readings:

1. General Microbiology. Stainer RY, Ingraham, JL, Wheelis ML, Painter PR. The Macmillan Press Ltd. 5th Ed. (2007),
2. Principles of Microbiology, Atlas RM, Mosby (2005)
3. Microbiology-Principles and exploration, Black JG, Prentice Hall 7th Ed. (2008)
4. Prescott's Microbiology, Prescott, Harley and Klein Willey, Linda, 8th Edition (2010)
5. James G. Cappuccino, Natalie Sherman. Microbiology: A Laboratory Manual. Pearson Benjamin Cummings (2013)

BIT-DSEC-502 BIOMOLECULES Credit 4

Course Objectives:

CO1: This course aims to introduce biomolecules, their structures and roles in biological systems.

CO2: To impart knowledge on the basic experiments in biomolecules and the utility of experimental methods in a problem oriented manner.

Learning Outcomes: On successful completion of this course, student are expected to learn the following

LO1: Understand the structures of carbohydrates, amino acids, proteins, lipid and nucleic acid

LO2: Understand the biological roles of biomolecules

LO3: To run the biomolecules experiments confidently and operate the basic laboratory instruments as well as understand the principles of the experiments.

Theory Credit 3

Unit l

Classification, chemistry and biological significance of carbohydrate: monosaccharides-classification and structure, isomerism in monosaccharides, disaccharides, oligosaccharides, polysaccharides: hetero-polysaccharides, and homo-polysaccharides; storage polysaccharides and structural polysaccharides.

Unit 2

Structure, properties, classification and biological function of amino acids, peptides, proteins (Eg: Hemoglobin, Myoglobin). Structural hierarchy in proteins: primary, secondary, quaternary structure, super-secondary structures: motifs and domains of proteins. Classification, structure and chemistry of nucleotides-purine and pyramidine, nucleic acid-DNA and RNA. Non-genetical roles of nucleotides.

Unit 3

Structure, classification and biological significance of lipid: oils and fats, triglycerides, phospholipids, glycolipids, cholesterol and its derivatives. Heterocyclic compounds and secondary metabolites in living systems: pigments, isoprenoids, alkaloids, flavonoids, phenols.

Unit 4 (Practical) Credit 1

1. Quantitative reactions of amino acids
2. Quantitative reactions of reducing sugars
3. Quantitative reactions of cholesterol
4. Quantitative reactions of proteins
5. Quantitative reactions of nucleic acids

Suggested Readings:

1. Harper's illustrated Biochemistry (A & L Lange Series), Rodwell VW, Bender D, Botham KM, et al. McGraw Hill/Medical, (2018), ISBN10-1259837939/ISBN13-978-1259837937
2. Lehninger Principle of Biochemistry, 8th ed. Nelson DL and Cox MM, W.H. Freeman (2021), ISBN-10:1319228003/ISBN13-978-1319228002
3. Biochemistry, 4th ed. Voet D, Voet JG. John Wiley and Sons. ISBN-978-0-470-57095-1
4. Biochemistry, 9th ed. Stryer L, Berg J, Tymoczko J, Gatto G. WH Freeman (2019), ISBN-1319114679
5. Biochemistry, 1st ed. Miesfeld RL, McEvoy MM. WW Norton & Company, (2017), ISBN-10-0393615081/isbn-13-979-03993615081
6. An Introduction to Practical Biochemistry (2017) 3rd ed., Plummer D. T., Tata McGraw Hill Education Pvt. Ltd. (New Delhi), ISBN: 978-0070994874.
7. Principles and Techniques of Biochemistry and Molecular Biology (2018) 8th ed. Keith Wilson & John Walker, Cambridge University Press. ISBN: 131661476X.

BIT-DSEC-503 FUNDAMENTALS OF BIOINFORMATICS Credit 4

Course Objectives: To provide basic skills in bioinformatics, data science and computational biology

Learning Outcomes: After completing this course, a student is expected to learn the following:
LO1: Practical skills in the selected domains of Bioinformatics
LO2: Understanding of major concepts of skills in Bioinformatics.
LO3: Understanding the scope and applications of this knowledge.

Theory Credit 3

Unit 1
Concept of databases, Biological Databases – primary, secondary and specialized biological databases, data information retrieval systems, fundamental analysis and visualization of protein structure, identification of regulatory elements, concept of DOTPLOT

Unit 2
Protein motif and domain prediction, Ramachandran Plot, Lysosomal and membrane proteins, Protein secondary structure prediction, trans membrane topology prediction, Protein structure classification-CATH and SCOP

Unit 3
Methods of Sequence Analysis: Pairwise sequence alignment methods; Heuristic Methods; BLAST and its variants, Statistics of Sequence Alignment; E-Value, P-Value, Scoring matrix (PAM and BLOSUM); Multiple Sequence Alignments.

Unit 4 (Practical) Credit 1

1. Use of advanced literature search (PubMed)
2. Homology based search
3. Sequence retrieval and analysis
4. Usage of biological databases

Suggested Readings:

1. Marketa Zvelebil and Jeremy O. Baum, Understanding Bioinformatics, Garland Science
2. Rastogiet. al., Bioinformatics: Methods and Applications, Prentice Hall of India.
3. Dan E. Krane and Michael L. Raymer, Fundamental Concepts of Bioinformatics, Pearson Education.
4. Claverie & Notredame, Bioinformatics - A Beginners Guide, Wiley-Dreamtech India Pvt Ltd.
5. Bioinformatics: A practical guide to the analysis of genes and proteins. 2. Baxevanis A.D and Ovellette B.F.F., Wiley-Interscience, (2002).
6. Textbook of Biotechnology Das H.K., Wiley Dreamtech India Pvt Ltd, (2004).
7. Principles of Genome analysis and genomics, Primrose SB, Twyman RM, Blackwell Science (2002).

BIT-GEC-503 BIOSTATISTICS Credit 4

Course Objectives:
To introduce the students the student to the field of statistics, make them understand what it is all about and how various biological phenomena including experiments and their data can be quantitatively measured and mathematically analyzed with confidence by providing various examples.

Learning Outcomes: On successful completion of this course, student are expected to learn the following

LO1: To understand the field of statistics, and its utility in the experimental analysis of data and its logical interpretation. They will be adept in statistical analysis of experimental data.

Unit 1
Concepts in Statistics: Data types & presentation, Frequency distributions, Populations and samples, Random sampling, Parameters and statistics, outliers from a population; qualitative and quantitative data; cross-sectional and time series data; discrete and continuous data. Collection and scrutiny of data: Primary data

Unit 2
Permutation & Combination, Sets. Probability: Definition, Sample space and Events; Adding & Multiplying probabilities, Conditional probability. Measures of central tendency: Arithmetic mean, median, mode; Coding of data. Measures of variability & dispersion: Range, Mean deviation, Variance, Standard deviation, Coefficient of variation,

Unit 3
Probability Distribution: Normal distribution, Binomial distribution, Poisson distribution. Normal Distribution: proportion of a normal distribution, Distribution of means, Statistical hypothesis testing, Confidence limits, Symmetry & Kurtosis. One—Sample hypothesis: One-tailed vs two-tailed hypothesis, Sample size, Detectable difference & Power in tests.

Unit 4
Two-sample hypotheses: Testing difference between two means, Test with unequal variances, Paired sample Hypotheses. Nonparametric statistical methods. Multiple sample hypotheses and Analysis of variance: Single factor analysis, Multiple Comparisons. Nonparametric analysis of variance. Simple Linear Regression and Correlation, Rank Correlation. Testing for Goodness of fit: Chi-Square analysis.

Suggested Readings:

1. Biostatistical Analysis (2010) 5th edition, Jerrold H Zar, Pearson International Education, USA
2. Fundamentals of Biostatistics (2004), Dutta N. K., Kanishka Publishers.
3. An Introduction to Biostatistics (2005), Gurumani N., MJP Publishers.
4. Biostatistics- A Foundation for Analysis in the Health Sciences (2007), Daniel, W. W., Wiley.
5. Biostatistics – A Manual of Statistical Methods for use in Health Nutrition and Anthropology (2007), .Rao, K. V., Jaypee Borthers Medical Publishers
5. Principles of Biostatistics (2007), Pagano, M., Gauvreau, K. & Mattie H., Chapman & Hall/CRC Press.
6. Intuitive Biostatistics: A Nonmathematical Guide to Statistical Thinking (2013), Harvey Motulsky, Oxford University Press.

SECOND SEMESTER

BIT-CC- 505 MOLECULAR BIOLOGY Credit 4

Course Objectives:

CO1: To understand the basic structure and function of DNA, DNA replication, transcription, modification of RNAs & DNA repair.

CO2: To understand the features of translation, genetic code, charged tRNA, regulation of translation and protein targeting.

CO3: To design and experiment in molecular biology

Learning Outcomes: On completion of the course, students are expected to learn the following:

LO1: Current fundamental concepts on structure and function of RNA & DNA

LO2: Clear understanding of the molecular basis of genetic information and function.

LO3: Develop skills in performing DNA/RNA related experiments and assays.

Theory Credit 3

Unit1

Mechanisms of DNA replication in viruses, bacteria and eukaryotes, semi-conservative mode of DNA replication, theta model and rolling circle model of DNA replication. DNA polymerases, Okazaki fragments, replication fork (prokaryotes and eukaryotes), Detailed mechanisms of DNA repair (base excision repair, nucleotide excision repair, mismatch repair etc), structure and properties of RNA polymerases in prokaryotes and eukaryotes.

Unit 2

Prokaryotic and eukaryotic gene structure. Mechanisms of transcription in prokaryotes and eukaryotes. General and specific transcription factors, Mechanism of post-transcriptional modifications of RNAs, Splicing, RNA editing. Translation: features of genetic code, amino-acyl tRNA synthases and charging tRNA, prokaryotes and eukaryotes translation, regulation of translation. Protein qulaity control, turn-over and degradation

Unit 3

Regulation of gene expression: prokaryotic gene expression with reference to inducible and repressible operons. Concepts of eukaryotic gene regulation, chromatin remodeling. Epigenetics, chromatin marking systems. Regulatory RNA: basic concepts of miRNA, siRNA and RNAi. Functional genomics.

Unit 4 (Practical) Credit 1

1. Extraction of genomic DNA (human / mouse)
2. PCR amplification of DNA
3. Extraction of RNA from human cells / tissue
4. Conversion of RNA into cDNA with reverse transcriptase
5. PCR amplification of cDNA
6. Gel electrophoresis of PCR / RT-PCR product

Suggested Readings:

1. Genes XII, (2017) 12th Revised edition ed., Lewin B, Krebs J, Kilpatrick ST, Goldstein ES, Jones and
   Bartlett Publishers, Inc. Sudbury, Massachusetts, USA. ISBN No. 9781284104493.
2. Molecular Biology of the Gene (2013) 7th ed., Watson JD, Baker TA, Bell SP, Gann A, M, Levin RL and Cumming B, San Francisco, ISBN: 0321905377.
3. Molecular Biology of the Gene (2017) 7th ed., Watson JD, Pearson Education (India), ISBN: 9789332585478, 9332585474
4. Molecular Biology (2018) 3rd ed., Clark D, Pazdernik N and McGhee M, Academic Cell Press (Maryland, USA), ISBN: 9780128132883
5. The Cell: A Molecular Approach (2018) 8th ed., Cooper GM, Sinauer Associates is an imprint of Oxford University Press, ISBN: 1605357073.
6. Molecular Cell Biology (2016) 8th ed., Lodish H, Berk A, Zipursky SL, Matsudaira P, Baltimore D and Darnell J, W.H. Freeman &Company (New York), ISBN: 978-1-4641-0981-2 / ISBN:10: 1464183392.
7. Principles and Techniques of Biochemistry and Molecular Biology (2018) 8th ed. Wilson K, and Walker J, Cambridge University Press. ISBN: 131661476X.
8. Genetics: A Laboratory Manual, (2009) 2nd ed., American Society of Agronomy; Lab Manual edition, ISBN: 978-0891185611.

BIT-CC-506 IMMUNOLOGY Credit 4

Course Objectives

CO1: To enable students to understand the fundamental principles, technical aspects and applications in the field of immunology.

CO2: To develop an understanding about practical aspects of immunology and impart skills to design and perform various tests/assays and experiments

Learning Outcomes: On successful completion of this course, student are expected to learn the following

LO1: Have an understanding of the cells, receptors and molecules of the innate immune system

LO2: Elucidate cytokines and complement based activation and regulation of immune mechanisms

LO3: Acquire insights on B- and T-cell development and their functions

LO4: Acquire knowledge of principles and application of some common immunological techniques and perceive knowledge on immunodeficiency.

LO5: To evaluate the interaction between antigen and antibody through the techniques learned during the experiment

LO6: Learn how to handle animal model; Learn to differentiate the blood cells morphologically.

Theory Credit 3

Unit 1

Basic concepts in immunology, cells of immune system, phylogeny 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. Antibody structure and function, antigen-antibody interactions.

Unit 2

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-Iymphocytes; Cytokines and their role in immune regulation, Inflammatory responses, Tcell regulation, MHC restriction; Immunological tolerance, Autoimmunity, Immunomodulation.

Unit 3

Hypersensitivity: types, features and mechanism of immediate and delayed hypersensitivity reactions; immunity to microbes (protozoa, bacteria, fungi, intracellular parasites, helminths & 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.

Unit 4 (Practical) Credit 1

1. Separation of mononuclear cells by histopaque.
2. Isolation and identification of macrophages.
3. Differential WBC count.
4. Raising of antiserum in mouse/rabbit and immunodiffusion studies in agar gels.
5. Pattern of Antigen-antibody interactions using in vitro-double immunodiffusion
6. Immunoelectrophoresis
7. Western blotting
8. ELISA

Suggested Readings:

1. Molecular Biology of Cell, 5thed. Alberts B et al. Garland Publishers, (2008).
2. Kuby Immunology, Goldsby RA., Kindt Thomas J, Osbame BA., WH Freeman & Company, 6th ed. (2006).
3. Immunology-Understanding the Immune System Elgert K.D, Wiley Liss, 2nd Ed. (2009).
4. Roitt's essential Immunology, Roitt I.M. and Delves PJ., Blackwell Science Ltd., 12thEd. (2012).
5. Practical immunology, 4th ed. Hay FC, Westwood OMR. Blackwell Science Ltd. (2002) Print ISBN:9780865429611/Online ISBN:9780470757475
6. A handbook of practical immunology, Talwar GP, Gupta SK. Delhi CBS Publisher (2003).
7. Roitt's essential Immunology, Roitt 1Mand Delves PJ, BI~ckwell Science Ltd., 12th Ed. (2012).

BIT-DSEC-507 MICROBIAL TECHNOLOGY Credit 4

Course Outcomes:

CO1: The students will be introduced to the developments/advances made in field of microbial technology for use in human welfare and solving societal problems.

CO2: The students will be introduced to the laboratory techniques in microbial technology

Learning Outcomes:

LO1: On completion of this course, students would develop deeper understanding of the microbial technology and its applications.

LO2: On completion of this course, students would develop skill for culturing and optimizing the growth of microbes of industrial importance.

Theory **Credit 3**

Unit 1

Microbial genetics: Regulation of bacterial gene expression, mutations, genetic transfer, DNA amplification using PCR, manipulation of gene expression in prokaryotes, increasing protein production, expression and application in *E. coli*, plasmids, antibiotic resistance markers transformation in *E. coli*. microbes in production of alternative energy; microbial endophytes and novel metabolites; patenting.

Unit 2

Nature of microbial polysaccharides, mechanism of synthesis; significance of mcrobi al steroids and sterols: screening for microbial products; microorganism for waste treatment; Immobilization of microalgae for pollutant removal.

Bioprocess technology, beer brewing, cheese manufacture, mold–modified foods, Wine, Vinegar. Diagnostic clinical microbiology (emerging and re-emerging infectious diseases, microscopy, culture & sensitivity);

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, Elementary principles of microbial reaction engineering, probiotics. Introduction to bio-insecticides, biofertilizers.

Unit 4 (Practical) **Credit 1**

1. Microbial population enumeration techniques
2. Biochemical identification of unknown bacteria
3. Nucleic acid isolation from bacteria.
4. Amplification of bacterial DNA and Electrophoretic separation.
5. Microbial Production of citric acid, amylase, alcohol and antibiotics.
6. Effect of temperature and pH on growth of *E. coli*
7. Effect of carbon and nitrogen on microbial growth.
8. Demonstration of carbohydrate fermentation, indole production, catalase test, oxidase test.

Suggested Readings:

1. General Microbiology, Stainer RY, Ingraham JL, Wheelis ML. & Painter PR. The Macmillan Press Ltd., 5th Ed. (2007).
2. Microbiology-Principles and exploration, Black JG, Prentice Hall 7th Ed. (2008
3. Microbial Biotechnology, Glazer AN, Nikaido H, WH Freeman and Company 2nd Ed. (2007)
4. Bioprocess Engineering: Basic Concepts (2nd ed), ML Shuler, & F K argi , Prentice Hall, Engelwood Cliffs. 2014
5. Principles of Fermentation Technology (2nd edition), PF Stanbury, A Whittaker and SJ Hall,Pergamon P ress, Oxford. (2013).

BIT-DSEC-508 ADVANCED BIOINFORMATICS Credit 4

Course Objectives:

CO1: To provide the students with advanced methods in bioinformatics

CO2: To acquaint the students with applications of bioinformatics in diverse fields of biology.

Learning Outcomes: On completion of the course, the students will learn the following

LO1: Good understanding of sequence analysis

LO2: Some of the latest techniques in drug designing

LO3: Understanding of genomics and its analysis

Theory Credit 3

Unit 1

Introduction of computer networks- Topologies and designs; Introduction to Markup language- Hyper Text Markup Language (HTML), concept of PERL programming, concept of data mining and artificial intelligence.

Unit 2

Introduction to the internet and its application, Needleman-Wunch algorithm, Smith-waterman algorithm, Graphical mode of sequence alignment, sequence logo-creation and consensus logo, Concept of profiles and patterns

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, QSAR, reverse pharmacology, drug metabolism and toxicity, homology modelling of proteins and energy minimization.

Unit 4 (Practical) Credit 1

1. Analysis of nucleotide and protein sequences
2. Protein structure annotation
3. Interactome analysis
4. Analysis of metabolic pathways
5. Specialised biological database search

Suggested Readings:

1. Bioinformatics: Sequence and Genome Analysis by Mount D., Cold Spring Harbor Laboratory Press, New York. 2004
2. Introduction to bioinformatics by Teresa K. Attwood, David J. Parry-Smith. Pearson Education. 1999 Old editions
3. Bioinformatics: A practical guide to the analysis of genes and proteins. Baxevanis A.D and Ovellette B.F.F., Wiley-Interscience, (2002).
4. Textbook of Bioctechnology Das H.K., Wiley Dreamtech India Pvt Ltd, (2004).
5. Principles of Genome analysis and genomics, Primrose SB, Twyman RM, Blackwell Science (2002).
6. Biostatistics-A foundation for Health Science, Daniel WW, John Wiley10th ed. (2013).
7. Statistical Methods, Medhi J, Willey Eastern Limited, (1992).

BIT-RM-509 RESEARCH METHODOLOGY AND PROPOSAL WRITING Credit 4

Course Objectives:

CO1: To give a brief account of the history of research

CO2: To point up the methodologies used to do research, understanding the effective lab practices and ethics

CO3: To prepare structural framework for research and learn the art of analysis

CO4: To understand practical aspects of research and learn proposal writing.

Learning Outcomes: On successful completion of this course, student are expected to learn the following:

LO1: To help students create and organize ideas and objectives for their dissertation

LO2: To prepare the students to adapt to the research environment and understand how projects are executed in a research laboratory

LO3: To prepare the students to present their topic of research and explain its importance

Unit 1: History of Science and Scientific Research

Empirical science; scientific method; manipulative experiments and controls; deductive and inductive reasoning; descriptive science; reductionist vs holistic biology

Unit 2: Preparation for Research

Choosing a guide, finding a lab and research question; maintaining a lab notebook.

Unit 3: Proposal Preparation

Choosing a topic of interest, Literature survey, preparation of hypothesis and proposal, making a work plan for quantitative and qualitative assessment of the research question/problem

Unit 4: Proposal Presentation

Presentation of the topic of their project proposal after selection of the topic. At the end of their project, the students will deliver presentation to explain their work in detail. Along with summarizing their findings they should also be able to discuss the future expected outcome of their work.

Suggested Readings:

1. Research methodology: Methods and techniques (2004) C.R. Kothari, 2nd revised.eds. New Age International Publishers.
2. Research methodology a step by step guide to beginners (2011) Ranjit kumar 6th ed. Sage Publications.
3. Research Design: Qualitative, Quantitative, and Mixed Methods Approaches (2017) J. David Creswell and John W. Creswell, 6th eds. Sage Publications.
4. Research Methods: A Practical Guide for Students and Researchers (2017) Willie Chee Keong Tanby World scientific publ.

BIT-SEC-510 LABORATORY SKILLS IN BIOTECHNOLOGY Credit 4

Course Objectives: To provide a basic understanding of tools and techniques in biotechnology.

Learning Outcomes: After completing this course, a student is expected to learn the following:
LO1: Practical skills in the selected domains of biotechnology.
LO2: Understanding of major concepts of skills in biotechnology.
LO3: Knowledge of the fundamental biochemistry knowledge related to health and diseases
LO4: Understanding of basic biochemical tests and bioinformatics tools relevant to the clinical conditions.

Theory **Credit 3**

Unit 1: Microbiology
Selection, collection and transport of specimens – Blood, Urine, Sputum, CSF, Pus & Faeces-transport media and storage. Microscopic examination of specimen for Bacterial pathogens– simple, differential staining and motility. Identification of organisms - Biochemical reaction– Sugar fermentation test, Susceptibility testing –MIC.

Unit: 2: Biochemistry
Laboratory diagnosis of disorders associated with glucose metabolism, lipoprotein metabolism and amino acid metabolism; Plasma proteins in health and disease; Enzymes associated with cardiac, pancreas, hepatic and renal functions; Laboratory assessment of hormones produced by thyroid gland, parathyroid gland, adrenal gland and pancreas.

Unit 3: Molecular biology
Background of development of PCR, Real time PCR and its variations, application of PCR for diagnosis of infectious diseases, Restriction endonuclease and its applications in pathogen identification, DNA fingerprinting, DNA array in genetic analysis and identification of disease genes.

Unit 4: (Practical) **Credit 1**
1. PCR using DNA/RNA
2. Extraction of DNA/RNA
3. Reporter assay
4. Protein modelling and validation
5. Bacterial transformation
6. Antibiotic production and assay
7. Microbial resistance against drugs.

Suggested Readings:
1. Diagnostic Microbiology, Bailey and Scott's., 1990. Eighth edition. The C.V. Mosby Company.
2. James Cappuccino. Microbiology: A Laboratory Manual (10th Edition).
3. Tiwari, G. S. Hoondal, Laboratory Techniques In Microbiology & Biotechnology. Swastik publishers. 2005.
4. William Claus. G.W. 1989. Understanding Microbes – A Laboratory textbook for Microbiology, W.H. Freeman and Co., New York.

5. Bioinformatics: A practical guide to the analysis of genes and proteins. Baxevanis A.D and Ovellette B.F.F., Wiley-Interscience, (2002).
6. Principles of Genome analysis and genomics, Primrose SB, Twyman RM, Blackwell Science (2002).
7. Medical Biochemistry, 6th Edition (2022) by John W Baynes, Marek H. Dominiczak. Elsevier Publisher, Paperback ISBN9780323834506/Ebook ISBN: 9780323834513
8. Mark's Basic Medical Biochemistry: A Clinical Approach, 5th Edition (2017) by Lieberman M, Alisa P. Lippincott W. and Wilkins Publication. *ISBN*-10. 160831572X · *ISBN*-13. 978-1608315727
9. Textbook of Biochemistry with Clinical Correlations an Indian Adaptation 7th Edition (2022) By Devlin TM. Wiley. 9789354641558

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THIRD SEMESTER

BIT-CC-600 APPLIED MOLECULAR GENETICS Credit 4

Course Objectives

CO1: To learn, understand and apply techniques to characterize molecular mechanisms.
CO2: To utilize the knowledge to enhance understanding of plant and animal sytems.
CO3: To impart basic knowledge in mapping of plant population using various DNA markers and cytogenetic approaches.

Learning outcomes: On completion of the course, a student is expected to have learnt the following:
LO1: Principles and application of gene technologies involved in the improvement of life forms.
LO2: Various gene technologies used to identify the genetic aberrations for disease prognosis and amelioration thereof.
LO3: Hands-on-training/expertise in basic molecular/genetic techniques.

Theory Credit 3

Unit 1

Basic of human Genetics, Heredity, Alleles, the concept of Genetics polymorphism; Population Genetics, Genetic markers; Gene mapping: Identifying human disease genes, LOD score analysis, Whole genome and Exome sequencing.

Unit 2

Disorders of Haemoglobin: Sickle cell anaemia, Thalassemia, Phenylketonuria, Maple Syrup urine syndrome, Galactosemia; Disorders of Carbohydrate metabolism, Disorders of Muscle and Eye: Dystrophies, Myotonias, Myopathies, Retinitis pigmentosa, cataract; Multifactorial diseases: Hyperlipidaemia, Atherosclerosis, Diabetes mellitus. Neurodegenerative disorders: Alzheimer's and Parkinson's.

Unit 3

Plant genome mapping: Types of mapping population; RFLP and AFLP mapping. Marker assisted breeding using RFLP, AFLP, RAPD, SNP and CAPS marker. Application of molecular cytogenetic techniques: Chromosome banding, FISH, GISH, chromosome painting and CGH analysis. T-DNA and Transposon tagging: Role of gene tagging in gene analysis, T-DNA and transposon tagging, identification and isolation of genes through T-DNA or transposons.

Unit 4 (Practical) Credit 1

1. Genetic fidelity test in plant with RAPD markers.
2. Genomic DNA isolation from blood.
3. Amplification of tumor suppressor gene.
4. Reverse-transcription- Polymerase chain reaction.
5. Identification of a protein using Western blot.

Suggested Readings:

1. Genetics of common diseases (2020), Day I NV and Humphries SE, Garland science, eBook ISBN: 9781003076810
2. Genetic disorders and the fetus (2021) 8th edition, Milunisky A & Milunisky JM, Wiley and Sons, ISBN:9781119676935
3. Genetic Analysis: An Integrated Approach (2018) 3rd edition, Sanders MF and Bowman JL, Pearson Publisher, ISBN: 9780134605173 0134605179
4. Approaches to Gene Mapping in Complex Human Diseases (1998), Haines JL & Pericak-Vance MA, Wiley, ISBN-13. 978-0471171959
5. Human Genetic Disease Analysis (1993) 2nd edition, Davies KE, IRL Press.
6. Emery and Remoin's Principles and Practice of Medical Genetics and Genomics (2018) 7th edition, Reed Pyeritz, Bruce Korf, Wayne Grody, Academic Press, ISBN: 9780128125366.
7. Molecular cloning: A laboratory manual (2000), Sambrook J, Fritsch EF and Maniatis T, Cold Spring Harbor Laboratory Press, New York.
8. Practical methods in Molecular Biology (2011), Schleif RF and Wensink PC, Springer-Verlag New York, eBook ISBN978-1-4612-5956-5.
9. Prasad B.D. (2021). Plant Biotechnology, Volume I (Principle, technique & Application), Apple Academic Press, ISBN 9781774631102
10. 10. Glick B.R. (2017), Methods in Plant Molecular Biology and Biotechnology, CRC Press, Boca Raton, eBook ISBN: 9781351074490

BIT-CC-601 ANIMAL BIOTECHNOLOGY Credit 4

Course Objectives

CO1: To make the student understand the principles, tools and techniques required for animal cell cultures, including stem cells, assisted reproductive technology, development of transgenic animals, and development of animal models for human diseases.

CO2: To provide hands-on training in animal cell culture technology.

Learning Outcomes: Following completion of the course, student is expected to learn the following:

LO1: The methods involved in culturing animal cells.

LO2: Various techniques involved in creating transgenic animals.

LO3: To utilize animal production technologies.

LO4: Culture and maintaining animal cells and verifying cell line identity through DNA analysis.

Theory Credit 3

Unit 1

Structure & organization of animal cells, Primary and established cell lines, Induced pluripotent stem cell (iPSC), Cell synchronization, Cell viability and cytotoxicity, Scaling-up of animal cell culture, Cell cloning, Cell transformation, Three dimensional culture; Somatic cell genetics: interspecific somatic cell genetics and its application in human chromosome mapping.

Unit 2

Overview of transgenic technology: Biopharming through animal transgenesis; Methods of producing transgenic farm animals; Identification and transfer of gene in production and disease resistance, Reproduction biotechnologies and livestock; Somatic cell nuclear transfer cloning; In vitro Fertilization, Embryo production, preservation and transfer; Sperm and embryo sexing; Intracytoplasmic sperm injection (ICSI); Cryopreservation and gamete banking.

Unit 3

Recombinant therapeutics and production of pharmaceuticals; Production of tissues and organs and xenotransplantation; Gene therapy, Retrovirus and adenovirus mediated gene therapy.

Unit 4 (Practical) Credit 1

1. Cultivation of continuous cell lines.
2. Quantification of cells by trypan blue exclusion dye.
3. Isolation of DNA from cultured cells.
4. MTT assay to study the effect of toxic chemicals on cultured mammalian cells.
5. Cryopreservation of cell primary cultures and cell lines.

Suggested Readings:

1. Animal cell culture: a practical approach, Oxford University Press (2010) 6th Edition, Freshney RI, Wiley- Blackwell, ISBN: 978-0-470-52812-9.
2. Text Book of Animal Biotechnology (2013), Singh B, and Gautam SK, TERI, ISBN: *9788179933275*
3. *Advances in Animal Biotechnology (2020), Singh B, Mal G, Gautam SK, Mukesh M, Springer Nature,* ISBN-10 : 3030213110
4. Animal Cell Culture and Technology (2003), Butler, M., Taylor & Francis, *ISBN 9781859960493*
5. Freshney RI. (2010). Culture of Animal Cells (2010), Freshney RI, *Wiley- Blackwell, ISBN: 978-0-470-52812-9*
6. Animal Cell Biotechnology (2020) 4th Edition, Portner R, Humana Press, ISBN: 9781071601914, http://pi.lib.uchicago.edu/1001/cat/bib/12022703
7. Cell Culture Technology (2018), Kasper C et al., Springer Nature, ISBN: 978-3-319-74853-5
8. Cell Culture Techniques.(2011), Aschner M et al., Springer, ISBN: 978-1-4939-5813-9

BIT-CC-602 PLANT BIOTECHNOLOGY Credit 4

Course Objectives

CO1: To learn, understand, and apply molecular and biochemical technologies used by plant scientists to characterize plant molecular mechanisms.

CO2: To utilize the knowledge to enhance crop productivity and food security of the nation.

CO3: To impart training in application of basic molecular techniques in plants.

Learning Outcomes: On completion of the course, student is expected to learn the following:

LO1: Understand the principles and gene technologies involved in the improvement of crops for better agronomic characters.

LO2: To utilize plant biotechnologies for sustainable agriculture and food security.

LO3: To utilize the plant molecular biology techniques as assets for future development of sustainable agriculture and food security

Theory Credit 3

Unit 1

Concepts of totipotency in plants; Different modes of regeneration; plant regeneration protocols and culture methods; Plant hormones and their role in differentiation and development; Plant micropropagation methods; Hardening and acclimatization; Anther culture for production of haploids, embryo culture and embryo rescue technique; Artificial seeds; Protoplast culture and fusion; Conservation of plant resources: cryopreservation and DNA banks for germplasm conservation.

Unit 2

Conventional methods for crop improvement: Principles of plant breeding, Breeding methods for self and cross-pollinated crops, Heterosis breeding, Mutation breeding; Limitations of conventional breeding; Gene transfer in plants: Vector and transformation in plants, nuclear and chloroplast transformation; Organization of Ti plasmids; Ti plasmid based and physical DNA delivery; Analysis of transgenic plants. Marker Assisted Selection (MAS), Gene pyramiding.

Unit 3

Developing herbicide resistance in plants; Engineering male sterility in crop plants; Barnase and barstar systems; Genetic engineering of plants for insect resistance; Engineering plants for abiotic stress tolerance; Molecular farming; Transgene stability and gene silencing; Farmer's and Breeder's rights.

Unit 4 (Practical) Credit 1

1. DNA Isolation from plants
2. Restriction digestion of DNA
3. Restriction Fragment Length Polymorphism (RFLP) analysis in plants
4. Callus induction, micropropagation and organogenesis

Suggested Readings:

1. Glick B.R. (2017), Methods in Plant Molecular Biology and Biotechnology, CRC Press, Boca Raton, eBook ISBN: 9781351074490
2. Adrian Slater, Nigel Scott and Mark Fowler, Plant Biotechnology: The genetic manipulation of plants, 2nd Edition, Oxford University Press, 2008
3. Prasad B.D. (2021). Plant Biotechnology, Volume I (Principle, technique & Application), Apple Academic Press, ISBN 9781774631102
4. Malik Z.A. (2017), Plant Biotechnology: Principles and Applications, Springer Nature, ISBN: 978-981-10-2959-2
5. Govil C.M. et al., (2017), Plant biotechnology and genetic engineering, PHI Learning Private Ltd., ISBN: 978-81-23-5314-5.
6. Practical Book of Biotechnology & Plant Tissue Culture (2010), Adhav S and Adhav M, S. Chand Publication, ISBN: 978-8121932004.
7. Plant Biotechnology: Practical Manual (2007), Giri CC and Giri A, I K International Publication House, ISBN: 978-818986614.
8. Plant Tissue Culture: An Introductory Text (2013) by Sant Saran Bhojwani and Prem Kumar Dantu , Springer
9. Principles of Plant Genetics and Breeding (2020) by George Aquaah, Wiley and Blackwell

BIT-DSEC-603 BIOPROCESS ENGINEERING AND ENZYMOLOGY Credit 4

Course Outcomes

CO1: To know about the fundamental concepts of bioprocess technology and its related applications, in order to meet the challenges of the new and emerging areas of biotechnology industry.
CO2: Students will be able to investigate, design and conduct experiments, analyse and interpret fermentation data.
CO3: To provide deeper understanding about enzyme structure, function, kinetics and mechanism of action.
CO4: To enhance knowledge about other forms of biocatalysts such as abzyme, Ribozyme

Learning Outcomes

LO1: Students will be able to appreciate relevance of microorganisms from industrial context and carry out stoichiometric calculations and specify models of their growth.
LO2: Present o design and operations of various fermenters unit operations together with the fundamental principles for basic methods in production techniques for bio-based products;
LO3: Calculate yield and production rates in a biological production process, and also interpret data.
LO4: Give an account of important microbial/enzymatic industrial processes.
LO5: Understand the fundamentals of enzyme properties, mechanisms and regulation.
LO6: To distinguish different types of enzyme inhibitors and their application in medicine.
LO6: To have knowledge about the existence of other biocatalyst such as abzyme, ribozyme and their applications.

Theory Credit 3

Unit 1

Isolation, preservation and maintenance of industrial microorganisms; Kinetics of microbial growth and death; Estimation of biomass; Open and closed systems; Product formation in microbial cultures; Batch, Fed-batch and continuous bioreactions, stability of microbial reactors, analysis of mixed microbial populations, specialized bioreactors (pulsed, fluidized, photobioreactors); Sterilization of bioreactors, Sterilization and Pasteurization, Elementary idea of food canning and packingfood preservation, fermented foods and probiotics.

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, application of computers in bioprocess engineering (data logging, analysis and control). Enzyme and cell immobilization and their industrial applications.

Unit 3

Enzymes: enzyme properties, classification, isolation, characterization, enzyme purity, enzyme units; Energetics of enzyme catalyzed reactions; Active site mapping, Mechanism of enzyme catalysis; Regulation of enzyme activity; Allosteric enzymes, Iso-enzymes, Multienzyme system; Enzyme kinetics: Michaelis-Menten equation and its derivatives, significance of Vmax and Kcat; Bisubstrate reactions; Enzyme inhibitions; effects of organic solvents on enzyme catalysis and structural consequences; Ribozymes, Abzymes, Synzyme.

Unit 4 (Practical) **Credit 1**

1. Isolation of industrially important microorganisms.
2. Determination of thermal death point (TDP) and thermal death time (TDT) of a microorganism for the design of a sterilizer.
3. Determination of the growth curve of a given microorganism
4. Determination of generation time of bacteria and effect of temperature, pH and substrate on its generation time.
5. Determination of substrate degradation profile during microbial growth.
6. Compute specific growth rate (m) and growth yield ($Y_{x/s)}$ from the above.
7. Comparative studies of Ethanol production using different substrates.
8. Production and assay of alkaline protease.
9. Effect of temperature, pH, metal ions on enzyme activity.
10. Determination of characteristics of enzyme catalyzed reactions (V_{max}, K_m) in presence and absence of inhibitor

Suggested Readings

1. Bioprocess Technology: Fundamentals and Applications, KTH, Stockholm. (2000)
2. Bioprocess Engineering: Basic Concepts (2nd edition), ML Shuler, and F K argi Prentice Hal l, Engelwood Cliffs. (2003)
3. Principles of Fermentation Technology (2nd edition), PF Stanbury, A Whittaker and SJ Hal l, Pergamon Press, Oxford. (1995)
4. Bioreaction Engineering Principles, J Nielson, and J Villadsen, Plenum Press. (2003)
5. Biochemical Engineering, J M Lee, Prentice Hall Inc. (2009)
6. Principles of Fermentation Technology (2nd edition), PF Stanbury, A Whittaker and SJ Hall, Pergamon Press, Oxford. (1995)
7. Microbial Biotechnology, Principles and Applications, LY Kun (Ed). World Scientific. (2003)
8. Lehninger Principles of Biochemistry (7th edition) DL Nelson and M Cox, WH Freeman. (2017)
9. Biochemistry (9th edition), JM Berg, JL Tymoczko, L Stryer, WH Freeman &Co Ltd. (2019).
10. Enzymes: Catalysis, Kinetics and Mechanisms, NS Punekar, Springer. (2018).

BIT-DSEC-604 ENVIRONMENTAL BIOTECHNOLOGY, IPR AND BIOENTREPRENEURSHIP **Credit 4**

Course objectives

CO1: To know about environmental issues and their mitigation and protection, control of pollution

CO2: To develop understanding of toxins, carcinogens and xenobiotic prevalent in the environment and their detection.

CO3: To develop practical understanding of the organisms present in the Environment and learn the safety concerns while working with microbes.

CO4: To provide basic understanding of IPR issues including patent laws, filing of patents, copyright acts and use of trademarks.

Learning outcomes: At the end of the course, students will be able **to:**

LO1: Identify the environmental issues and work towards their remediation

LO2: Understand and analyse the toxic factors in the environment and their detection.

LO3: Develop an understanding of the interactions of microbes with chemicals and their detection.

Theory **Credit 3**

Unit 1

Concept and scope of Environmental biotechnology; Role of biotechnology in environmental protection; Environmental monitoring tools, role of microbial systems; Biodegradation, biotransformation, bioconversion, bioremediation and detoxification technology; Toxic chemicals in the environment, sources, mode of entry; Xenobiotics; Carcinogens in air, chemical carcinogenicity, mechanism of carcinogenicity, environmental carcinogenicity testing; Biomarkers detection.

Unit 2

Solid waste management methods: Sanitary land filling, Recycling, Composting: types, Incineration; Hazardous Waste Management; Sources & Classification, physicochemical properties; Hazardous Waste Control & Treatment; Primary, secondary & tertiary & advance treatment of various effluents sewage and recycling; Production of value added products from waste; Heavy metals and their interactions with soil components, Use of microbes in mineral beneficiation and oil recovery.

Unit 3

Patents, Copyright & Related Rights and relevance to Biotechnology, GATT and WTO; Filing of a patent application; Bio-entrepreneurship:decision and assessment of feasibility of a given venture/new venture; Assessment of market demand for potential product(s) of interest; Copyrights and Neighbouring Rights, Universal Copyright Convention; Concept of trademark and trademark law, Infringement of trademark; Passing off and deceptive similarity.

Unit 4 (Practical) **Credit 1**

1. Isolation and characterisation of microbes from aerobic and anaerobic habitats.
2. Production of antibiotics/antimicrobials and growth inhibition assay
3. Comparative studies of Ethanol production using different substrates.
4. Production and assay of Alkaline Protease.
5. Detection of coliforms for determination of the purity of potable water.
6. Estimation of nitrate in drinking water.

Suggested readings

1. Environmental Biotechnology: Theory and Application (2013)Gareth G. Evans and Judy Furlong, Wiley Blackwell publisher
2. Environmental biotechnology (2012) Jogdand SN., Himalaya Pub. House.
3. Wastewater microbiology (2011) G. Britton, 4th eds, by Wiley-Blackwell.
4. Environmental Microbiology: from genomes to biogeochemistry.(2008), 1st ed. E.L.Madsen by Blackwell publishing.
5. Environmental Microbiology,(2015) 3rd eds, IL Pepper, C.P.Gorba, T.J Gentry by Academic Press.
6. Wastewater microbiology (2011) G. Britton, 4th eds, by Wiley-Blackwell.
7. Environmental Microbiology,(2015) 3rd eds, IL Pepper, C.P.Gorba, T.J Gentry by Academic Press.
8. Intellectual Property: The Law of Trademarks, Copyrights, Patents and Trade Secrets, Deborah E. Bouchoux, Cengage Learning, Third Edition, 2012.
9. Intellectual Property Rights: Unleashing the Knowledge Economy, Prabuddha Ganguli McGraw Hill Education, 2011.

BIT-DSEC-605 GENETIC ENGINEERING AND BIOSAFETY Credit 4

Course Outcomes:

CO1: Students will understand the various principles and technologies for how to manipulate DNA, RNA and shuffling of genes in order to understand the biological mechanisms at molecular levels.

CO2: Students will be acquainted with the versatile tools and techniques employed in genetic engineering and recombinant DNA technology.

CO3: Apply the principles of molecular biology and its applications in genetic engineering and learn the biosafety standards.

Learning Outcomes

LO1: Students will develop strong theoretical knowledge of genetic engineering and biosafety issues.

LO2: Students will be able to take up biological research in relevant biotech R&D industry including Ph.D. programmes.

Unit 1

Genetic engineering as a tool in biotechnology; Indian Biosafety Statutory Bodies (RDAC, IBSC, RCGM, & GEAC); Biosafety levels for specific microbes and infectious agents; Bioethics; GMOs release and associated risks; Molecular tools in genetic engineering: Restriction enzymes, DNA/RNA modifying enzymes, DNA cloning vectors and their use in various systems; Gene cloning strategies: insertion of DNA molecules in vectors, Linkers and adaptors; Genomic library construction and screening for recombinant DNA clone; Reverse transcriptase and cDNA synthesis, RT-PCR, cDNA library construction and screening.

Unit 2

Analysis of gene regulation: Northern analysis and Western blotting; Gel retardation technique; DNA footprinting, Primer extension, S1 mapping, Ribonuclease protection assay, Reporter assays; Site-directed mutagenesis; Construction of Transgene, knockout, knock-in and conditional knockout in animals or plants, CRISPR/Cas9 systems in gene editing, Construction of microarrays–genomic arrays, cDNA arrays and oligo arrays

Unit 3

PCR- Principle and applications; Microsatellites and minisatellites; DNA fingerprinting; Chromosome walking; DNA transfection, labelling of DNA and RNA probes; Fluorescence *in situ* hybridization, DNA sequencing and sequence assembly, Next generation sequencing.

Unit 4

Cloning for gene expression: Industrial production of animal and plant proteins in microbes, industrial application of genetic engineering, industrial production of recombinant proteins; Application of genetic engineering in plants and animals for enhancement of disease resistance, agronomic traits and pharmaceuticals; Gene therapy.

Suggested Readings:

1. Old, R. W., Primrose, S. B., & Twyman, R. M. (2001). *Principles of Gene Manipulation: An Introduction to Genetic Engineering*. Oxford: Blackwell Scientific Publications.
2. Green, M. R., & Sambrook, J. (2012). *Molecular Cloning: a Laboratory Manual*.
3. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
4. Brown, T. A. (2006). *Genomes* (3rd ed.). New York: Garland Science Pub.
5. Technical Literature from Stratagene, Promega, Novagen, New England Biolabs *etc.*

FOURTH SEMESTER

BIT-DSEC-606 DISSERTATION Credit 20

Course Outcomes:

CO1: To prepare the students to adapt to the research environment and understand how projects are executed in a research laboratory.

CO2: To enable students to learn practical aspects of research and train students in the art of analysis and thesis writing.

Learning Outcomes

LO1: Students should be able to learn how to select and defend a topic of their research, how to effectively plan, execute, evaluate and discuss their experiments.

LO2: Students should be able to demonstrate considerable improvement in the following areas:

- In-depth knowledge of the chosen area of research.
- Capability to critically and systematically integrate knowledge to identify issues that must be addressed within the framework of specific thesis.
- Competence in research design and planning.
- Capability to create, analyse and critically evaluate different technical solutions.
- Ability to conduct research independently.
- Ability to perform analytical techniques/experimental methods.
- Project management skills.
- Report writing skills.
- Problem solving skills.
- Communication and interpersonal skills.

Paper Code	Paper	Credit	No. of Papers	Total Credits
BIT-DSEC-606	Dissertation		1	20
	Problem Identification, Review of Literature, Proposal Writing and Presentation Dissertation: Experiments, Data Collection and Analysis and Discussion	16		
	Dissertation Presentation and Viva	4		
Total		**20**	**1**	**20**

N.B: *Study tour for students will form part of the curricular activities as the subject is applied and exposure visits are important for learning emerging trends and developments in biotechnology.*

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