

M.Sc. Biotechnology (CBCS) Revised Syllabus(2020)
The University of Burdwan

MSBT 101 BIOCHEMISTRY (THEORY)

2 Credit

Unit I

Scope and importance of Biochemistry; Structure of water; Acid base concept and buffers; pH; Hydrogen bonding; Hydrophobic, Electrostatic and Vander Waals forces; ATP as energy currency; Brief concept on free energy.

Unit II

Amino acids: structure and nature (polar, non-polar, acidic, basic, hydrophobic and hydrophilic etc); specific rotation, D, L and R, S Configurations, Electrochemical properties, isoelectric properties, absorption properties.

Proteins: classification of structures: primary, secondary, tertiary and quaternary; classification based on function and composition;

Structure and stability of sugars, cellulose, glycogen and starch.

Unit III

Enzymes and vitamins: water soluble vitamins and co-enzymes; lipid soluble vitamins and co-factors.

Enzymes: Classes of enzymes, active and binding sites; holo and apo enzymes; enzyme activity; enzymes inhibitors and activators; Enzyme kinetics- Michealis-Menten equation derivation; significance of kinetic parameters: k_M and v_{MAX} ; enzymes inhibition kinetics: competitive, uncompetitive, mixed and non-competitive.

Unit IV

Intermediary metabolism: Glycolysis; TCA; Gluconeogenesis; Pentose phosphate pathway.

Unit V

Nitrogen fixation and assimilation; Biosynthesis and regulation of essential amino acids, lipids and nucleic acids.

SUGGESTED BOOKS:

1. Lehninger's Principles of Biochemistry by D.L. Nelson and Michael M. Cox
2. Biochemistry by D. Voet and J. G. Voet
3. Basic Stereochemistry of Organic Molecules by Subrata Sen Gupta
4. Physical Chemistry for the Life Sciences by P Atkins and J d Paula
5. Physical Chemistry by P. C Raskhit
6. Protein Structure and Function by G A Petsko and D Ringe
7. Biochemistry by L Stryer.

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BIOCHEMISTRY (Practical)

2 Credit

1. General Methods for calculation, determination of solute concentration.
2. Titration of amino acids (neutral, acidic and basic) for determination of PI and pKa.
3. Qualitative tests for proteins and amino acids, Sugars and carbohydrates.
4. Quantitative test for DNA, RNA, Proteins and Sugars.
5. Preparation of different biological buffers.
6. Spectroscopy: Recording spectra of Protein and Nucleic acids and analysis of characteristic features of the spectra.

SUGGESTED BOOKS:

1. Experimental *biochemistry*: a student companion by [Beedu Sashidhar Rao](#), [Vijay Deshpande](#)
2. Principles and techniques of practical biochemistry by K. Wilson
3. Practical Biochemistry by V. K. Malhotra

MSBT 102 CELL BIOLOGY (THEORY)

2 Credit

1. Cell organelles:

1.1. Nucleus –Structure & function of Nuclear envelop, Nuclear lamina & nucleolus-r-RNA Biogenesis
Macromolecular trafficking & across the nuclear envelop, Chromatin organization & packaging, Ultra structure of Lampbrush and Polytene chromosome.

1.2 Mitochondria – Structure, organization of respiratory chain complexes, ATP synthase, Structure – function relationship, Mitochondrial DNA and inheritance.

1.3 Chloroplast - Structure & function, Genome Organization & Biogenesis, Chloroplast DNA, Chloroplast biogenesis

1.4. Endomembrane system& Cell motility- Structure & function of microbodies, Golgi apparatus, lysosome, Endoplasmic reticulum. Organisation& role of microtubules & microfilaments.

2. Membrane system: Biological Membranes- Architecture & kinetics (transport, ion channels, diffusion, Na-K pump, Proton pump)

3. Cell cycle:

3.1. Phases, duration of different phases and the methods for their determination

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3.2 Molecular regulations of different Check points, Molecular mechanism of Cell cycle regulation, Cell cycle regulation in Yeast

3.3. Cell Cycle inhibitor

SUGGESTED BOOKS:

1. Cell by G M Cooper
2. Cell & Molecular Biology- Concepts and Experiments by Gerald Karp and Nancy L Pruitt
3. The Cell- De Robbertis and De Robbertis
4. Cell Biology by Pollard and Earnshaw

MSBT 102 CELL BIOLOGY (PRACTICAL)

2 Credit

1. Study of method of preparation of Fixative, Pre-treating chemical and Stain
2. Study of different stages of mitosis, mitotic index & chromosome complement of *Allium cepa/ Allium sativu, Lens culinaris*
3. Study of different stages of meiosis in *Allium cepa, Rhoeo discolor*, Grasshopper
4. Study of Polytene Chromosome of *Chironomus* sp.

SUGGESTED BOOKS:

1. The Cell by De Robbertis and De Robbertis
2. Chromosome Techniques : Theory and Practice by Arun Kumar Sharma , Archana Sharma

MSBT 103 DEVELOPMENTALBIOLOGY (THEORY)

4 Credit

1. Novel features of plant development
2. Shoot apical meristem (SAM) and Root apical meristem (RAM).Apical basal and Radial pattern formation in *Arabidopsis thaliana*
3. Genes in development of embryo from zygotic cell division in *Arabidopsis thaliana*, Hormonal regulation of polarity, endosperm development in plants
4. Phy gene- Types, mechanism of action, Genetic analysis of phytochrome function .

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5. Floral meristem and Floral organ development: Organisation of floral organ, modification of floral organ, Role of Homeotic gene in determination of floral organ in *Arabidopsis thaliana*, ABC and ABCDE model, MADS- box.

6. Early embryonic development in Animals: Cleavage –Types and mechanism, Gastrulation- Movements involved; Cell specification with respect to amphibian and chick

7. Zygotic genes (gap gene, pair rule gene & segment polarity gene) in pattern formation; antero posterior embryogenesis in *Drosophila*; homeotic genes in *Drosophila*, Hox gene in mammals.

SUGGESTED BOOKS:

1. Genetics by W.S Klug & M R.Cummings
2. Plant Physiology by L. Taiz & E . Zeiger
3. Developmental Biology by Scott F. Gilbert

MSBT 104 MOLECULAR BIOLOGY (THEORY)

2 Credit

1. Central dogma of molecular biology
2. Structure and renaturation kinetics of DNA
3. Replication, DNA topology, DNA damage and repair in prokaryotes
4. Transcription in prokaryotes and eukaryotes, Operon concept
5. PCR types and its applications.
6. Post transcriptional modifications of RNA, gene silencing, anti-sense RNA, RNAi, SiRNA, Translation in prokaryotes and eukaryotes, protein targeting,
7. Biosignaling, basic ideas about signal transduction
8. Transposons and retroposons: prokaryotic and eukaryotic transposable Elements and their roles.

SUGGESTED BOOKS:

1. Molecular Biology- Freifelder
2. Molecular Biology of the Gene- J.D.Watson
3. Genetics - Klug and Cummins
4. Gene - Benjamin Lewin (10th edition)
5. Cell - G M Cooper

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MSBT 104 MOLECULAR BIOLOGY (PRACTICAL)

2 Credit

1. Isolation of genomic DNA of plants and bacteria
2. Agarose gel electrophoresis
3. Phage titration by plaque assay
4. SDS-PAGE of proteins

MSBT 105 ANALYTICAL TECHNIQUES (THEORY)

2 Credit

1. Microscopy: Light, Phase contrast microscope, Fluorescence microscope, SEM & TEM, Confocal Microscope
2. Chromatography: Gel filtration, ion- exchange, affinity, TLC, GC, HPLC, FPLC, Electrophoresis, Electrofocussing, Centrifugation
3. Sequencing of DNA and proteins
4. Blotting and hybridization techniques: Southern, Northern and Western Blotting
5. DNA fingerprinting and foot printing, chromosome walking, DNA microarrays
6. Analytical and preparative Ultracentrifugation and its application
7. Principle and application of spectroscopy.
8. Circular dichroism and its application.
9. Real time PCR and its application

Suggested Books

1. Modern NMR techniques for chemistry research by Andrew E. Derome
2. Molecular Spectroscopy by Jack D. Gray Beal
3. The elements of physical chemistry: with applications in biology by P. W. Atkin's
4. Principles and Techniques of Biochemistry and Molecular Biology by K. Wilson and J. Walker
5. Cell & Molecular Biology- Gerald Karp

MSBT105 ANALYTICAL TECHNIQUES (PRACTICAL)

2 Credit

1. Separation techniques- Centrifugation, chromatography (paper, TLC, Silica Gel Chromatography) and Electrophoresis.
2. General Concept of Spectrophotometry, Electrophoresis
3. Demonstration of PCR (including Real time PCR), HPLC, GCMS, SEM and FM.

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SUGGESTED BOOKS:

1. Molecular Microbiology: *Diagnostic Principles and Practice* by David H. Persing
2. Molecular Biotechnology (Principle and Practices) Channarayappa
3. Molecular Cloning: A laboratory Manual Vol. 1, 2, 3
4. Principles of Practical Biochemistry by Wilson & Walker.

MSBT 0106 BIostatistics AND COMPUTER APPLICATION (THEORY)

2 Credit

1. General discussion about Statistics, Biostatistics and its application in Biological Science. Brief description and tabulation of data and its graphical representation for different data type (grouped and ungrouped).
2. Measurement of central tendency: Mean Median, Mode, Range, Standard Deviation, and Variance for different data type (grouped and ungrouped), Idea of two types of error and its level of significance, Chi-Square Test, Simple linear regression and correlation, Probability Distribution (Binomial, Poisson, Gaussian).
3. Basic commands of DOS and LINUX
4. Introduction of digital computer: Low and High level language, binary system. Difference between software and programme.
5. Programming in C: Introduction, Data Types, Condition checking and looping, Function, Array, String Handling.

MSBT 0106 BIostatistics AND COMPUTER APPLICATION (PRACTICAL)

2 Credit

1. Solving the problems of Biostatistics (Average, Median, Mode Mean Median, Mode, Range, Standard Deviation, and Variance for different data type (grouped and ungrouped), Chi square, Correlation coefficient, Normal/Poisson Distribution, t-test, z-test etc.) through MS- Excel.
2. Basic commands of DOS and LINUX.
3. Computer Application: Programming for Solving Statistical problems (Mean, Median (sorting), Mode, Standard Deviation, and Variance for different data type (grouped and ungrouped), Correlation Coefficient) through C programming.

SUGGESTED BOOKS:

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1. Statistics in Biology and Psychology; Author: Debojyoti Das and Arati Das
2. Introduction to Biostatistics; Author: N.G.Das
3. Introductory Statistics; Author: Prem S. Mann
4. Mathematical Statistics and Data Analysis; Author: John A. Rice.
5. Biostatistics: A foundation for analysis in the Health sciences; Author: Wayne W. Daniel.
6. Introduction to LINUX/UNIX; Author: Sumitabha Das
7. PROGRAMMING IN ANSI C; Author: E.Balagurusamy
8. Let us C; Author: Yasbant Kanetkar
9. Electronics – Fundamentals and Application; Author: P.C. Rakshit

MSBT 201 IMMUNOLOGY (THEORY)

2 Credit

1. Immunology-fundamental concepts and anatomy of the immune system.

- 1.1. Components of innate and acquired immunology.
- 1.2. Antigens- immunogens, requirements for immunogenicity, haptens, antigen antibody interactions, affinity and avidity, adjuvant, cross reactivity; antigen presenting cells (APC).
- 1.3. Major Histocompatibility complex (MHC)- MHC genes, antigen processing and presentation.

2. Immune responses generated by lymphocytes.

- 2.1. Immunoglobulins- Basic structure, classes & subclasses, antigenic determinants, action of antibody, kinetics of immune response, B cell receptor, B-cell maturation and activation, monoclonal antibodies, clonal selection theory.
- 2.2. Multigene organization of immunoglobulin genes, generation of antibody diversity, class switching, allelic exclusion, affinity maturation.
- 2.3. Cytokines and its properties (pleiotropy, redundancy, synergy, antagonism).
- 2.4. T-cell and cell mediated immunity-structure of T-cell receptor molecules, function of T-cells.

3. Clinical immunology.

- 3.1. Hypersensitive reactions (Type I, II, III and IV).
- 3.2. Auto immunity, example of some auto immune diseases.
- 3.3. Tissue transplantation and graft rejection.

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SUGGESTED BOOKS:

1. Kuby, RA Goldsby, Thomas J. Kindt, Barbara, A.Osborne, Immunology, 6th Edition, Freeman, 2002.
2. Brostoff J, Seaddin JK, Male D, Roitt IM, Immunology, 6th Edition, Gower Medical Publishing, 2002.
3. Paul, Fundamental of Immunology, 4th Edition, Lippencott Raven, 1999.

MSBT 201 IMMUNOLOGY (PRACTICAL)

2 Credit

1. Microscopic observation of blood cells (RBC & WBC).
2. Blood grouping and allo-antigen classification.
3. Study of sex chromatin.
4. Dot blot
5. Isolation and characterization of Antibody.

SUGGESTED BOOKS:

1. F.C. Hay, O.M.R. Westwood, Practical Immunology, 4th Edition- Blackwell Publishing,2002.
2. Ed Harlow, David Lane, Antibodies Laboratory Manual, ColdSpring Harbor, Laboratory Press,1988.

MSBT 202 MICROBIOLOGY & INDUSTRIAL APPLICATIONS (THEORY)

2 Credit

Unit I

Outline of cell wall, cell membrane, capsule, slime, flagella, pili, flagellar movement, non-flagellar movement, Reserve materials and cytoplasmic inclusions of bacteria, principles of staining (Gram staining, Endospore staining, Acid fast staining, Negative staining)

Unit II

Archaeobacteria (Thermophiles, Halophiles and Acidophiles), Eubacteria, Cyanobacteria, Industrially important microorganisms (bacteria)

Unit III

A brief outline of virology (History, Classification, Structure), Viruses (Bacterial, Plant, Animal viruses-basic ideas), Virioids and Prions.

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Unit IV

Bacterial growth in liquid media and solid media, Diauxic growth, Growth requirements, growth factors, Kinetics of growth, Continuous culture, Synchronous culture, Enrichment culture with examples.

Unit V

Transformation, Conjugation and Transduction (Outline), Quorum Sensing

Unit VI

Nitrogen cycle- Nitrification, Denitrification, Mechanism of biological N₂ fixation

Unit VII

Industrial production of ethanol, citric acid, Antibiotic (penicillin), Amino acid (Tryptophan), Enzyme (Protease).

SUGGESTED BOOKS:

- 1) Pelczar MJ Jr, Chan ECS and Kreig NR., Microbiology, 5th edition, Tata McGraw Hill, 1993.
- 2) General Microbiology by Prescott.
- 3) Crueger and A. Crueger (English Ed., TDW Brock); Biotechnology: A Text book of Industrial Microbiology, Sinauer Associates, 1990.
- 4) Industrial Microbiology by I.E.Casida, JR.
- 5) G Reed, Prescott and Dunn's Industrial Microbiology, 4th edition, CBS Publishers, 1987.
- 6) Microbial Genetics: Maloy SR, Cronan JE Jr. and Frifielder D. Jones Barlett Publishers, Sudbury, Massachusetts, 2006.
- 7) Virology Principles and applications by Carter and Saunders (Wiley Publisher)

MSBT 202 MICROBIOLOGY (PRACTICAL)

2 Credit

Unit I: Aseptic Methods

Use of autoclave, hot air oven, laminar air flow, Sterilization of glass wares, Preparation and sterilization of culture media (Bacterial media, Fungal media), Preparation of slant and stab, Pure culture methods (streaking, pour plating and spread plate technique).

Unit II: Staining methods: Simple staining by crystal violet stain, Gram staining, Endospore staining

Unit III: Physiological and Biochemical tests

Catalase, Protease, Amylase, Indole, V.P, Acid and Gas production

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Unit IV: Assay of antibiotics

Agar cup method and paper disk method.

Unit V: Determination of Minimal Inhibitory Concentration of antibiotic.

Unit VI: Preparation of bacterial growth curve

SUGGESTED BOOKS:

- 1) Practical Microbiology by Dubey and Maheshwari.
- 2) Benson's Microbiological Applications, 10th edition (Laboratory Manual in General Microbiology)

MSBT 203 GENETIC ENGINEERING (THEORY)

2 Credit

1. Gene Manipulation—general concept, various tools scope and methodology
2. Cloning in *E. coli*: Vector plasmids, bacteriophages, cosmid, phasmid, Shuttle vectors, Cloning strategies; CDNA and genomic library construction.
3. Cloning in Yeast: Yeast vectors cloning and expression yeast artificial chromosome.
4. Cloning in plants: Agrobacterium mediated transformation, Ti and Ri plasmids, Binary vectors, plant specific promoters, incorporation of T-DNA into nuclear DNA of plant cells. Transgenic plants with insect resistance, herbicide resistance, RFLP/RAPD/AFLP mapping techniques.
5. Cloning in animals: Integration of DNA into mammalian cells, applications.

SUGGESTED BOOKS:

1. Gene-Benjamin Lewin (10th edition)
2. Principles of gene manipulation-Primrose and Twyman and Old,2001
3. Recombinant DNA-James D. Watson
4. Principles and Techniques of Practical Biochemistry 5th edition-K. Wilson and J. Walker
5. Genomes 3rd edition-T. A. Brown, 2006

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MSBT 203 GENETIC ENGINEERING (PRACTICAL)

2 Credit

1. Isolation of plasmid DNA from bacterial cells
2. Transformation of E.coli cells with plasmid.
3. Restriction digestion of lamda phage genomic DNA, and plasmid DNA and analysis by agarose gel electrophoresis
4. PCR amplification of specific DNA sequence and analysis on agarose gel electrophoresis.

SUGGESTED BOOKS:

1. Molecular Cloning: A Laboratory manual, Vol: I-III cold Spring Harbor Laboratories, 2001
2. Molecular Biotechnology, 3rd edition-Glick, B. R. and Pasternak.

MSBT 204 GENETICS (THEORY)

2 Credit

1. **Mendelian genetics** – Mendel's experiment, Extention of Mendelian's principals, Incomplete dominance, co-dominance, multiple alleles lethal alleles, penetrance and expressivity, Epistasis, supplementary genes, pleiotropy, genomic imprinting.
2. **Genetic linkage, Crossing over and Chromosome mapping:** Recombination mapping with Three- point test cross, Tetrad analysis.
3. Numerical and Structural aberration of chromosome
4. **Cancer genetics** – Properties of malignant cells; benign and malignant tumor, properties of cancer cells, Genetic basis of cancer, tumor suppressor gene (P₅₃ & Rb gene), gate keeper gene and care taker gene, apoptosis.
5. **Population genetics:** Calculating allelic frequencies, Hardy - Weinberg equilibrium, Quantitative inheritance; QTL.

SUGGESTED BOOKS:

1. S.R. Maloy, J.E.Cronan, D.Friefelder, Microbial Genetics, 2nd Edition, Jones and Bartlett Publishers, 1994.
2. Mange E J and Mange A.P, Human Genetics, 2nd Edition, Sinauer Associates Publication, 1999.

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3. Hartl L D and Jones B, Analysis of genes and genomes, 3rd Edition, Jones and Bartlett Publishers, 1994.
4. Pastemak, An Introduction to Molecular Human Genetics, 2nd Edition, Fritzgarald, Wiley Liss, 2005
5. Wilson, Clinical Genetics, Wiley- Liss, 2000.
6. Robinson and Linden, Clinical Genetics Hand Book, 2nd Edition Blackwell Sciences, 1994.
7. WB Coleman and GH Tsangaris, Molecular Diagnosis for the Clinical laboratories, 2nd Edition, Human Press, 2000.
8. Genetics- B.D . Singh
9. Principle of Genetics –Snustad, Simmons and Gardner(Willey)

MSBT 204

GENETICS (PRACTICAL)

2 Credit

1. Chi-square test
2. Study of Cross over Frequency
3. Pedigree Analysis
4. Analysis of Gene frequencies following Hardy - Weinberg equilibrium.

SUGGESTED BOOKS:

1. Genetics- B.D . Singh
2. Principle of Genetics –Snustad, Simmons and Gardner(Willey)
3. Handbook of Practical Genetics - Vikas Pali

MSBT205

BIOINFORMATICS (THEORY)

2 Credit

1. Bioinformatics and its application in Biotechnology.
2. Biological databases (DDBJ, EMBL, GEN – BANK, Swissprot, PIR etc.), Sequence formats, Brief idea of Scoring/Substitution matrices: PAM and BLOSUM series and its significance, Definition and significance of Pairwise and Multiple Sequence Alignment, Gap opening and extension penalty, Score calculation Methods and algorithms used in Pairwise alignment: Dot

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Matrix, Dynamic Programming Algorithm (SW and NW) and k-tuple. Methods for doing MSA: CLUSTALW, Scoring MSA.

3. Algorithms used in Database similarity searching: BLAST.
4. Phylogenetic analysis: Concept and method: Distance based (UPGMA).

MSBT205 BIOINFORMATICS (PRACTICAL)

2 Credit

1. Searching for a particular literature through PubMed.
2. Use of Public Domain Interfaces for downloading different DNA and Protein sequences from authenticated Databases (Using NCBI).
3. Performing BLAST and interpretation of the results.
4. Performing MSA by using CLUSTALW and presentation of the phylogenetic tree.

SUGGESTED BOOKS:

1. Bioinformatics - Sequence and Genome Analysis; Author: David W. Mount
2. Introduction to Bioinformatics; Author: Teresa K. Attwood and David J. Parry Smith
3. Bioinformatics Concepts, Skills & Application; Author: S.C.Rastogri, Namita Mendiratta and Parag Rastogri.
4. Bioinformatics ; Author: david R. Westhead, J. Howard parish and Richard M. Twyman
5. Bioinformatics - Database, tools and algorithm; Author: Orpita Bosu, Simminder kaur Thukral
6. Discovering Genomics, Proteomics & Bioinformatics; Author :Campbell and Heyer.
7. Developing Bioinformatics Computer Skill; Author; Cynthia Gibas and Per Jambeck
8. Bioinformatics: a practical guide to the analysis of genes and proteins; Author: A. Baxevanis and F.B.F. Ouellette.

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MSBT206(A) IPR & BIOSAFETY (THEORY)

2 Credit

1. Intellectual Property: Trademark, copyright & related rights, Industrial Design Traditional knowledge, geographical Indications, Protection of new GMOs. International framework for the protection of IP in R&D. Case studies in Biotechnological innovations. Introduction to the history of GATT,WHO, WIPO and TRIPS.
2. Basics of Patents: Prior Art, Patent databases-International and country wise patent searches. Indian Patent Act 1970, Recent amendments .Filing of a patent application-provisional and complete specifications.PCT and Implications Patent Infringement-meaning scope ,litigation case studies.
3. Bio-safety : Introduction, Biological safety cabinets. Primary containment for Biohazards, Bio-safety levels. Bio safety guidelines-Definition of GMO's and LMO's. Role of International Biosafety committee. Environmental release of GMOs, Risk Analysis and Assessment. Overview of National Regulations and relevant International Agreements including Cartagena Protocol.
4. Bioethics: Concerns of biological hazards, Genetic engineering issues.

SUGGESTED BOOK:

1. IPR, Biosafety And Bioethics by Deepa Goel and Shomini Parashar

MSBT206(B) BIOENTERPRENEURSHIP (THEORY)

2 Credit

1. Starting the Enterprise: Understanding the Business of Biotechnology- Project Identification and selection-project formation-project appraisal-Institutional Finance and support to Bioentrepreneurship.
2. Managing the Enterprise: Basic issues relating to marketing like marketing planning, product management and new product decisions-Basic issues relating to Human Resource Management involving Acquisition, Development, Motivation, and maintenance of employees in technology-based firms-Fundamentals of accounting and Finance like Final accounts, Balance sheet, Financial analysis and Working Capital Management.
3. Sustaining the Enterprise: Emphasis on knowledge centers and R&D: Successful Biotech Business Strategies-Establishing network with Universities and research institutions-Technology Acquisition, Development and Transfer: Issues and Challenges for Bioentrepreneurs.

SUGGESTED BOOKS:

1. S.S. Khanka,Entrepreneurial Development, S.Chand: New Delhi
2. Poornima M. Charantimath, Entrepreneurship Development and Small Business Enterprises, Pearson Education: New Delhi

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3. S.N.Jogdand, Entrepreneurship and Business of Biotechnology, Himalaya: New Delhi
4. Ryan Baidya and Miyuki Shiratani, Biopreneurs: The Molecular Millionaires, California Takshila University: Santa Clara.
5. Philip Cooke and Dafna Schwarz (Eds). Creative Regions: Technology Culture and Knowledge Entrepreneurship, Routledge.
6. Rajan Saxena, Marketing Management, Tata McGraw-Hill: New Delhi

MSBT 301 BIOPROCESS ENGINEERING & TECHNOLOGY (THEORY) 2 Credit

1. Basic Principle of Biochemical engineering:
What is biochemical engineering? Gene products and their processing, modification and application: utilization of gene products in basic and applied metabolism.
2. Application of Enzymes in food, leather & paper industry:
Isolation and purification of enzymes, immobilization of enzymes: enzyme engineering; synzymes, Uses of enzymes in food & beverage, textile, paper, leather industries.
3. Applications of Microbes in food process operation and production:

Edible vaccines, production of single cell protein (SCP), commercial production of biofuels, Biopesticides, biofertiliser, biomineralization & phytomining.
4. Concepts of basic mode of fermentation processes:

Bioreactor design, Types of fermentation & fermenters, solid state fermentation, aerobic and anaerobic fermenter.

MSBT 301 BIOPROCESS ENGINEERING & TECHNOLOGY (PRACTICAL) 2 Credit

1. Isolation of industrially important microorganisms for microbial processes
2. Determination of growth curve of a supplied microorganism
3. Monitoring of dissolved oxygen during aerobic fermentation.
4. Cell disruption for endoenzymes by sonication.
5. Bioreactors (Demonstration)

SUGGESTED BOOKS:

1. Principles of Fermentation Technology by Stanbury, P.F., Whitekar A. and Hall. 1995., Pergaman. McNeul and Harvey.
2. Fermentations - A practical approach. IRL.
3. Bioprocess Technology: Fundamentals and Applications. Stockholm KTH.
4. Biochemical Reactors by Atkinson B., Pion, Ltd. London.
5. Biotechnology - A Text Book of Industrial Microbiology by Cruger.
6. Fermentation Biotechnology: Industrial Perspectives by Chand.
7. Biochemical Engineering Fundamentals by Bailey and Ollis, Tata McGraw Hill, N.Y.

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8. Biotechnology. Volume 3. Edited by H. J. Rehm and G. Reed. Verlag Chemie. 1983.
9. Advances in Biochemical Engineering by T.K. Bhosh, A.Fiechter and N. Blakebrough. Springer Verlag Publications, New York.
10. Bioseparation: Downstream processing for Biotechnology by Belter, P.A. Cussler, E.L. and Hu, W.S., John Wiley and Sons, N.Y.
11. Separation process in Biotechnology by Asenjo, J.A. Eds. Marcel Dekkar, N.Y.
12. Bioprocess Engineering Principles by Doran, Acad. Press, London.
13. Bioreaction Engineering Principles by Nielsen, J. and Villadsen, plenum Press, N.Y.
14. Fermentation, Biocatalysis and bioseparation, Encyclopedia of Bioprocess Technology by Chisti, Y., Vol. 5, John Wiley and Sons, N, Y.

MSBT 302 MOLECULAR VIROLOGY (THEORY)

4 Credit

Diagnostics for Sexually transmitted diseases (STD)

- I. Detailed Diagnostic Virology for
 - HIV (I & II),
 - HPV (High and low risk),
 - Hepatitis –HAV, HBV, HCV, HDV, HEV with special focus on HBV
 - HSV-HSV1, HSV2, VZV, EBV, CMV
- II. Diagnostic Bacteriology –Neisseria gonorrhoeae, Chlamydia trachomatis
1. Oncogenesis
 - Mechanism of oncogenesis: Acute Transforming virus and Oncogenesis, HTLV1, HTLV2
 - Carcinogens or mutagens detection by Ames' Salmonella assay
2. Drugs:
 - I. Drugs discovery and development ,
 - II. Understanding of target based design of drugs with suitable example.
 - III. ADME parameters, drugs action, metabolism and secretion.

SUGGESTED BOOKS:

1. Harrison's principles of internal medicine Volume I and Volume II by Tinsley Randolph Harrison, and Jean D. Wilson
2. Molecular Biology of Gene by J. D. Watson, T. A. Baker and Others
3. Molecular Microbiology: Diagnostic Principles and Practice by David H. Persing
4. Microbiology by Lansing M. Prescott, John P. Harley, Donald A. Klein
5. Fundamental of Immunology by Paul 4th Edition ,Lippencott Raven, 1999.
6. Microbiology by R A Harvey P C ,Champe and B D Fisher, Lippincott, William & Wilkins

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MSBT 303 IMMUNOTECHNOLOGY (THEORY) 2 Credit

Antigen - Antibody interactions:

I. Precipitation reactions- precipitation reaction in fluids& in gel, radial immunodiffusion(Mancini method), double diffusion (Ouchterlony method).

II. Agglutination- Prozone effect, direct agglutination and passive agglutination. Advanced immunological techniques- RIA, ELISA, Immunofluorescence, Immunoelectrophoresis. Active and passive immunization; live, killed, sub unit, DNA and recombinant vector vaccine

SUGGESTED BOOKS:

1. A Textbook of Immunology and Immunotechnology by B. Annadurai
2. Immunology and Immunotechnology by Pandian M.R.

MSBT 303 IMMUNOTECHNOLOGY (PRACTICAL) 2 Credit

1. ELISA Assay
2. Study of Immuno-precipitation, Agglutination and Immunodiffusion
3. Study of Immunofluorescence
4. Western Blot
5. Immuno- electrophoresis
6. Study of Primary and Secondary antibody response (Demonstration)

SUGGESTED BOOKS:

1. Handbook of Practical and Clinical Immunology by Talwar G P and Gupta S K
2. Practical Immunology by B Annadurai

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MSBT 304 GE MINOR ELECTIVE

A GENERAL IDEA ON BASIC AND APPLIED BIOTECHNOLOGY (THEORY)

2 Credit

1. An overview on genetics of human diseases.
2. A brief idea about antibiotics and vaccines.
3. Bioinformatics: Elementary concepts of microarray and drug designing.
4. Fundamentals of Tissue culture –(Totipotency, Basic idea on Callus culture, Shoot culture and Micropropagation, Haploid culture, Protoplast culture) ;

SUGGESTED BOOKS:

1. Plant Tissue Culture by M. K Rajdan
2. Plant Biotechnology by H. S. Chawla
3. Biotechnology by B.D. Singh

MSBT 305 DE MAJOR ELECTIVE

MSBT 305 -1 PLANT BIOTECHNOLOGY (THEORY)

2 Credit

1. Plant cell, tissue and organ culture: A brief history of plant tissue culture, totipotency, callus and cell s technology and its application.
2. Protoplast culture: isolation, purification, culture methods and regeneration of plants, Fusion of protoplasts, selection of somatic hybrid cells and regeneration of somatic hybrid plants, cybrids and cybridization technique.
3. Pollen Biotechnology: Anther & pollen culture- Technique and application, role in crop improvement, an outline of pollen based gene transfer technology
4. Micropropagation: Technique & application ; Micropropagation of horticultural, agricultural & forest tree plants.
5. *In vitro* conservation of plant cell and tissue culture & establishment of gene banks: Introduction ,technology of cryopreservation of germplasm.

SUGGESTED BOOKS:

1. Plant Biotechnology - H. S. Chawla
2. Plant Tissue Culture - M. K Rajdan

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- 3 .Agricultural Biotechnology- Purohit
4. Biotechnology- R.C.Dubey

- 5 .Plant Cell culture basics- C Evans

MSBT 305 -1 DE MAJOR ELECTIVE (PRACTICAL)

MSBT 305 -1 PLANT BIOTECHNOLOGY (PRACTICAL) 2 Credit

1. General process of sterilization and preparation of different culture media
2. Initiation and maintenance of callus
3. Study of organogenesis
4. Shoot tip and node culture and strategies of micropropagation

5. Protoplast culture.

6. Haploid culture.

SUGGESTED BOOKS:

1. Plant Cell Culture-A Practical Approach by Dixon and Gonzales
2. Plant Tissue Culture - Basic and Applied by Jha and Ghosh
3. Plant Tissue Culture-Techniques and Experiments by R H Smith

MSBT 305 -2 ANIMAL BIOTECHNOLOGY (THEORY) 2Credit

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 and 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, transformation; Application of animal cell culture ; Cell culture based vaccines. Stem cell cultures –embryonic stem cells and their applications .

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Somatic cell Genetics- Interspecific somatic cell genetics and its application in human chromosome mapping

SUGGESTED BOOKS:

1. Culture of Animal Cells: A Manual of Basic Techniques(5th Ed) - R Ian Freshney, Wiley –Liss
2. Animal Cell Culture Techniques(ed by Martin Clynes) ,Springer,1988

MSBT 305 -2 ANIMAL BIOTECHNOLOGY (PRACTICAL)

2 Credit

1. Handling of laboratory animals & Methods of breeding.
2. Preparation of animal tissue culture media and sterilization.
3. Isolation and quantification of DNA and RNA in animal tissue by spectrophotometer
4. Demonstration of monoclonal antibody production

SUGGESTED BOOKS:

1. Anatomy and Physiology of Farm Animals,(7th Edition) By- Rowen D. Frandson, W. Lee Wilke, Anna Dee Fails Wiley-Blackwell.
2. Animal Physiology by R.C.Sobti.
- 3 Principles of Animal Taxonomy by- George Gaylord Simpson
4. Ed.John RW. Masters, Animal Cell Culture- Practical Approach, 3rdEdition , Oxford University Press, 2000.
5. A.Puller (ed), Genetic Engineering in Animals, VCH Publishers.
6. Gordon, Reproductive Technologies in Farm Animals, CAB Intl., 2005.

MSBT 306 DE MAJOR ELECTIVE

MSBT 306-1 MICROBIAL BIOTECHNOLOGY (THEORY)

2 Credit

Unit I: Application of microbes for SCP production, Prebiotics and Probiotics

Unit II: Biopesticides, food processing and food preservation

Unit III: Glutamic acid (Amino acid), Streptomycin and Tetracyclin (Antibiotic), Lactic acid (Anaerobic fermentation), Vitamin A (Vitamin), Cheese and Yogurt (Milk products)

Unit IV: Microbial leaching

Unit V: Immobilization Technique

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UnitVI: Basic ideas of algal biotechnology, Application of algae as food supplement, Fungi of Veterinary & medical interest, role of fungi in food processing

SUGGESTED BOOKS & JOURNALS:

1. Industrial Microbiology by I.E.Casida, JR.
2. Industrial Microbiology by Crueger and A. Crueger (English Ed., TDW Brock)
3. Industrial Microbiology by Moat and Foster
4. G Reed, Prescott and Dunn's Industrial Microbiology, 4th edition, CBS Publishers, 1987 .
5. Journal: a) Nature Biotechnology b) Bioremediation(Taylor and Francis Publisher) c) Current Microbiology (Springer Journal) d) Trends in Microbiology e) Current opinion in Microbiology
6. Microalgae Algal Biotechnology by Backer, Cambridge
7. Algal Biotechnology by Borowitzka&Borowitzka
8. Fungal Biotechnology by Marcel Dekker
9. Industrial Microbiology by I. E. Casida, JR.
10. Industrial Microbiology by Crueger and A. Crueger (English Ed., TDW Brock)
11. Industrial Microbiology by Moat and Foster
12. G Reed, Prescott and Dunn's Industrial Microbiology, 4th edition, CBS Publishers, 1987.
13. Journal: a) Nature Biotechnology b) Bioremediation (Taylor and Francis Publisher) c) Current Microbiology (Springer Journal) d) Trends in Microbiology e) Current opinion in Microbiology

MSBT 306-1 MICROBIAL BIOTECHNOLOGY (PRACTICAL)

2 Credit

Unit I: Isolation of industrially important microorganism from different sources.

Endospore forming bacteria, nitrogen fixing bacteria (from soil), Phosphate solubilisers.

Unit II: Microbial production of citric acid.

Unit III: Amylase, Cellulase production test.

Unit IV: Bioremediation Technology.

Unit V: 16S rRNA gene based molecular phylogenetic approach for identification of bacteria.

MSBT 306 -2 COMPUTER SKILLS FOR BIOLOGICAL RESEARCH (THEORY)

2 Credit

1. Basics of computer and internet.
2. Introduction to DBMS and MySQL. Syntax for creation and manipulation of table and databases through MySQL.
3. PERL and SHELL programming language.
4. Introduction to R.
5. Functions and their Graphical Representation with Application in Biology: Linear-Power-Periodic-Logarithmic-Exponential functions.

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6. Matrix Algebra: Determinants with examples from biology, matrix as operation of reflection-rotation-inversion-magnification-translation-symmetry, applications in biology.

SUGGESTED BOOKS:

1. Bioinformatics - Sequence and Genome Analysis; Author: David W. Mount
2. Introduction to Bioinformatics; Author: Teresa K. Attwood and David J. Parry Smith
3. Bioinformatics Concepts, Skills & Application; Author: S.C.Rastogri, Namita Mendiratta and Parag Rastogri.
4. Bioinformatics; Author: david R. Westhead, J. Howard parish and Richard M. Twyman
5. Bioinformatics - Database, tools and algorithm; Author: Orpita Bosu, Simminder kaur Thukral
6. Discovering Genomics, Proteomics & Bioinformatics; Author :Campbell and Heyer.
7. Developing Bioinformatics Computer Skill; Author; Cynthia Gibas and Per Jambeck
8. Bioinformatics: a practical guide to the analysis of genes and proteins; Author: A. Baxevanis and F.B.F. Ouellette.
9. MySQL for beginners; Author: O'Reilly.
10. Programming Perl, Book by Larry Wall and Randal L. Schwartz

MSBT306-2 COMPUTER SKILLS FOR BIOLOGICAL RESEARCH (PRACTICAL) 2 Credit

1. MySQL
2. PERL
3. R
4. Linux and shell programming
5. Excel for advanced statistical analysis.

MSBT 307 CE COMMUNITY ENGAGEMENT ACTIVITIES

2 Credit

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MSBT 401 PROTEOMICS (THEORY)

4 Credit

1. General idea :
Definition, Classification, Scope and present advances. The emergence of proteome concept: structural and functional proteomes, Protein structures related to functional kinetics e.g. Prions.
2. Methods:
2D-PAGE, Mass Spectrometry with special emphasis on MALDI-TOF, peptide and protein Micro array technology. Application of these methods in proteomics.
3. Analytical Procedure and their Application:
Analytical methods, Bacterial and Yeast two hybrid System. Basic idea of Protein database
4. Transcriptomes: Basic ideas
5. Proteomics in relation to animal and plant health and welfare.

SUGGESTED BOOKS:

1. An introduction to proteomics tools for the new biology by Daniel C Liebler
2. Proteomics by T Palzkill
3. Protein Structure and Function by G A Petsko and D Ringe
4. Principles and Techniques of Biochemistry and Molecular Biology by K. Wilson and J. Walker
5. Two Hybrid Screening Wikipedia reading material

MSBT 402 GENOMICS (THEORY)

4 Credit

1. Salient Features of prokaryotic and Eukaryotic genome.
2. C-value paradox, Unique and Repetitive DNA, tandem and interspersed, Reassociation Kinetics, Determination of TM and Cot value.
3. Genome genomics : Concept and types.
4. Mapping genomes:
 - * Genetic mapping:- Linkage analysis is the basis of genetic mapping, Drawbacks.
 - * Cytogenetic mapping:- Concept, Fluorescence In situ hybridization, Radiation hybrid method, chromosome walking.
 - * DNA markers for genetic mapping.
 - * Physical mapping: Concept, Restriction mapping, RFLP mapping technique and application STS mapping technique in plant and human diseases. And application. Random amplified polymorphic DNA technique and application.
5. Digital DNA typing, DNA databases.

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6. Methodology for DNA sequencing: Maxam Gilbert method, Sanger's method, New generation sequencing.
7. An outline of Human genome project.

SUGGESTED BOOKS:

1. Genome 3: T. H. Brown
2. Chromosome Painting: A. K. Sharma
3. Principles of Genetics: Snustard & Simmons

MSBT 403 Review of Literature of a topic of Current interests and Seminar Presentation 4 credit

MSBT 404 DE

MSBT 404 -1 ADVANCED PLANT BIOTECHNOLOGY (THEORY) 4 Credit

1. Plant transformation: The basis of tumor formation, features of Ti-plasmid, mechanism of DNA transfer, role of virulence gene, binary vectors, Electroporation, Particle bombardment method, Chloroplast transformation, detection of transgene, identification of integration site, determination of copy number, inheritance of transgene.
2. Molecular markers: SNP, SSR, CAPS, Application of markers in breeding, genome editing and mutagenesis
3. Genome editing: Zinc finger nuclease, CRISPR technology, selection and application
4. Strategies for introducing Biotic & Abiotic stress Resistance/Tolerance: Herbicide, insect, virus, drought and salinity.
5. Plants as Biofactories: Concept of Biofactories, Cell culture for secondary metabolite production of pharmaceutically important compounds, elicitors, Hairy root culture
6. Genetic Engineering for Plant Architecture and Metabolism:
Molecular farming, its benefits & risks, long shelf life of fruits-Use of ACC synthase, ACC oxidase, Polygalacturonase, Male sterile line- barnase/barstar system. Golden rice, Seed-storage proteins, bioplastic, Terminator seed technology, Safety and social concern of GM crop; Metabolomics
7. Eco-Biotechnology: Biosensors : Types, Applications.
8. Patenting for biological materials, Plant breeders rights (PBR) & Farmer's rights

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SUGGESTED BOOKS:

1. Plant Biotechnology –Slatter, Scott and Fowler;
2. Plant Biotechnology- H.S. Chawla
3. Biotechnology- R.C. Dubey
4. Agribiotechnology and Plant tissue culture – S.S.Bhojwani
5. Current and future applications of genetically modified crops-N.G.Halford
6. Recent advances in plant biotechnology and its applications –A.K.Kumar and S.K.Sopory
7. Plant Biotechnology - R Keshavachandran and K V Peter

MSBT 404 -2 ADVANCED ANIMAL BIOTECHNOLOGY (THEORY)

4 Credit

Unit 1:

Assisted reproductive biotechnology (human and animal) - endocrine basis of reproduction, endocrine therapeutics. Reproductive ultrasonography and its application in OPU and ETT. Synchronization, Superovulation and embryo transfer technology, *in vitro* embryo production and micromanipulation of embryos, sperm and embryo sexing

Unit 2:

Transgenesis and its application - transgenic animal production, different methods of gene transfer (microinjection, calcium phosphate co-precipitation, lipofection, electroporation, nucleofection and viral vectors), transfection of DNA; embryo micromanipulation, Intra-cytoplasmic sperm injection; production of transgenic livestock, regulatory issue.

Genetic engineering of farm animals - cloning vectors, viral vectors, reproductive cloning, somatic cell nuclear transfer. Cloning of domestic animals, conservation of endangered species; Gene therapy - methods of gene therapy; Ethical issues in animal biotechnology.

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Unit 3:

Animal genomics - Genome organization in eukaryotes, Eukaryotic DNA markers. Importance of gene mapping in livestock, methods and techniques used for gene mapping (physical mapping, linkage analysis, cytogenetic techniques, FISH technique), somatic cell hybridization, *in-situ* hybridization.

Unit 4:

Trends in vaccinology - Molecular approaches to development of vaccines: recombinant peptide vaccines, vectored vaccines, DNA vaccines, genetically manipulated live vaccines, cell culture based vaccines. Idiotypic and synthetic peptide based vaccines, reverse genetic approach and computational vaccinology.

SUGGESTED BOOKS:

1. Anatomy and Physiology of Farm Animals,(7th Edition) By- Rowen D. Frandson, W. Lee Wilke, Anna Dee Fails Wiley-Blackwell.
2. Animal Physiology by R.C.Sobti.
3. Principles of Animal Taxonomy by- George Gaylord Simpson
4. Ed.John RW. Masters, Animal Cell Culture- Practical Approach, 3rdEdition , Oxford University Press, 2000.
5. A.Puller (ed), Genetic Engineering in Animals, VCH Publishers.
6. Gordon, Reproductive Technologies in Farm Animals, CAB Intl., 2005.

MSBT 405 -1 ADVANCED MICROBIAL BIOTECHNOLOGY (THEORY)

4 Credit

Unit I: Fermenter/ Bioreactor, Design of pilot plant fermenter, Different parts of fermenter and their uses, Scale up process, Outline of downstream processings.

Unit II: Biofertiliser & plant productivity: Bacterial- Nitrogen fixers symbiotic(*Rhizobium*),non-symbiotic(*Azotobacter*); Phosphate mobiliser(VAM), Vermicompost

Unit III: Strain improvement

Unit IV: Bioplastics

Unit V: Xenobiotics and recalcitrant compounds

Unit VI: Bioremediation with respect to Arsenic, Chromium, Lead and Mercury

Unit VII: Microbial degradation of insecticides.

SUGGESTED BOOKS & JOURNALS:

- 1) Industrial Microbiology by I. E. Casida, JR.
- 2) Industrial Microbiology by Crueger and A. Crueger (English Ed., TDW Brock)

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- 3) Industrial Microbiology by Moat and Foster
- 4) G Reed, Prescott and Dunn's Industrial Microbiology, 4th edition, CBS Publishers, 1987 .
- 5) Journal: a) Nature Biotechnology b) Bioremediation(Taylor and Francis Publisher) c) Current Microbiology (Springer Journal) d) Trends in Microbiology e) Current opinion in Microbiology

MSBT405-2 ADVANCED BIOINFORMATICS (THEORY)

4 Credit

1. Biological databases - Primary; Secondary/derived; structure (SCOP, CATH, PDB); metabolic pathway based (KEGG), Resources – NCBI; EBI; ExPASy.
2. Sliding window method in DOT matrix.
3. Substitution matrix – PAM and BLOSUM; generation and utility of different series.
4. Algorithm behind searching tools: BLAST; PSI-BLAST; PHI-BLAST; FASTA. Importance and creation of PSSM.
5. Dynamic programming algorithm and its use in sequence alignment. Multiple and Pairwise sequence alignment algorithms (Needleman and Wunsch; Smith and Waterman). Iterative refinement of MSA. Basic idea of MSA editors (CLUSTALW/X; CINEMA). Pattern searching algorithm: HASH-CODING.
6. Phylogeny: Terminologies; Molecular clock hypothesis; Conversion from unrooted to rooted; Tree generation methods – UPGMA; FM; NJ; Maximum Parsimony/Likelihood; Bootstrapping and use of PHYLIP.
7. Protein Secondary structure prediction.
8. Some parameters for genetic study like: RSCU, CAI etc.

SUGGESTED BOOKS:

1. Bioinformatics - Sequence and Genome Analysis; Author: David W. Mount
2. Introduction to Bioinformatics; Author: Teresa K. Attwood and David J. Parry Smith
3. Bioinformatics Concepts, Skills & Application; Author: S.C.Rastogri, Namita Mendiratta and Parag Rastogri.
4. Bioinformatics; Author: david R. Westhead, J. Howard parish and Richard M. Twyman
5. Bioinformatics - Database, tools and algorithm; Author: Orpita Bosu, Simminder kaur Thukral
6. Discovering Genomics, Proteomics & Bioinformatics; Author :Campbell and Heyer.
7. Developing Bioinformatics Computer Skill; Author; Cynthia Gibas and Per Jambeck
8. Bioinformatics: a practical guide to the analysis of genes and proteins; Author: A. Baxevanis and F.B.F. Ouellette.

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9. MySQL for beginners; Author: O'Reilly.

10. Programming Perl, Book by Larry Wall and Randal L. Schwartz

MSBT 406 PROJECT/TERM PAPER

4 Credit

Approved

A handwritten signature in blue ink that reads "Indrani Chandra". The signature is written in a cursive style with some decorative flourishes.

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9. MySQL for beginners; Author: O'Reilly.

10. Programming Perl, Book by Larry Wall and Randal L. Schwartz

MSBT 406 PROJECT/TERM PAPER

4 Credit

APPROVED

A handwritten signature in blue ink, appearing to read 'Santini Bandyopadhyay'.

Former Professor of Botany
Visva-Bharati
Santiniketan

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9. MySQL for beginners; Author: O'Reilly.

10. Programming Perl, Book by Larry Wall and Randal L. Schwartz

MSBT 406 PROJECT/TERM PAPER

4 Credit

Approved the above reconstructed syllabus

Dr. Santanu Pailan

Assistant Professor

The Department of Biotechnology

The University of Burdwan

Santanu Pailan

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The University of Burdwan

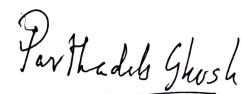
9. MySQL for beginners; Author: O'Reilly.

10. Programming Perl, Book by Larry Wall and Randal L. Schwartz

MSBT 406 PROJECT/TERM PAPER

4 Credit

Approved



(Parthadeb Ghosh)