

M.Sc Biotechnology Semester - I

Theory Papers

BT101 U - Genetics

BT102 U - Cell Biology

BT103 U - Biochemistry

BT104 U - Communication Skills, Computer Basics, Cyber Crime

Practical Papers

BT151 U - Genetics

BT152 U - Cell Biology

BT153 U – Biochemistry

M.Sc Biotechnology - BT101 U - Genetics

Credit 1: Principles of Genetics

- 1.1 Mendel's experiments Monohybrid ratios-Dominance and Recessive factors Law of segregation - Dihybrid and Tri hybrid ratios - Laws of independent assortments - Test cross and Back cross.
 - 1.1.1 Incomplete dominance - eg Flower Color.
 - 1.1.2 Co-dominance - eg MN Blood groups.
 - 1.1.3 Penetrance and Expressivity - Irregular dominance-eg: Polydactyly, Warrensburg Syndrome.
 - 1.1.4 Pleiotropism - Bardet Biedel Syndrome, Marfan's syndrome
 - 1.1.5 Phenocopy – microcephaly
 - 1.1.6 Chromosomal Theory of Inheritance
- 1.2 Extension to Mendel's Laws
 - 1.2.1 Multiple Allelism - eg. Coat color in Rabbits eye color in Drosophila, ABO Blood groups, Rh blood groups - incompatibility and pseudoallelism, Complex loci - R-locus in maize
 - 1.2.2 Non allelic interactions - Types of Epistasis, modification of dihybrid ratios.
- 1.3 Inheritance of quantitative traits - Additive effect - Skin color in man
- 1.4 X-Y chromosomes - Sex determination in Drosophila, Birds, Man, Bonellia
 - 1.4.1 X-linked inheritance - Hemophilia, Color blindness, X-inactivation
 - 1.4.2 Y-linked inheritance - Holandric genes
- 1.5 Inheritance patterns in Man - Pedigree analysis

Credit 2: Chromosome Organization and Chromosomal aberrations

- 2.1 Chromosome morphology - classification – karyotyping
- 2.2 Features of centromere and telomere
- 2.3 Specialised chromosomes - polytene & Lamp brush chromosomes
- 2.4 Euchromatin and Heterochromatin
- 2.5 Chromatin organization-Nucleosome, loops and Scaffolds
- 2.6 Nucleosome phasing
- 2.7 Chromatin under transcription.
- 2.8 Variation in chromosome number - Euploidy , Aneuploidy
- 2.9 Variation in chromosome structure deletions, duplication translocations and inversions

Credit 3 : Linkage and gene mapping

- 3.1 Cytological proof of crossing over
- 3.2 Phases of linkage, test cross, recombination frequency, gene mapping, determination of map distances based on two and three point test crosses, coincidence, Interference eg. Drosophila, Maize
- 3.3 Mitotic Crossing Over
- 3.4 Tetrad analysis – Neurospora
- 3.5 Gene mapping in man – Genetic mapping, sib pairs, Lod scores, homozygosity mapping, Linkage disequilibrium, TDT test

Credit 4 : Organellar Inheritance

- 1.1 Non- Mendelian Inheritance
 - 1.1.1 Variegation in leaves of higher plants- Mirabilis jalapa
- 1.2 Maternal inheritance - Poky in Neurospora, Shell coiling in snails Leber's Optic Atrophy in man
- 1.3 Uniparental inheritance - mutations in extra nuclear genes in chlamydomonas
 - 1.5.1 Other examples - Male sterility in Maize, S-gene in Nicotiana
 - 1.5.2 Plasmids, Is elements.

M.Sc Biotechnology - BT102 U - Cell Biology

Credit 1 : Internal Organisation of Cell

- 1.1 Membrane structure – lipid bi layer and membrane proteins
- 1.2 Electric properties of membrane
- 1.3 Transport across membranes – active transport, ionic gradient, carrier proteins, Na⁺ K⁺ pump, ATPase, ABC transporters, Ion channels
- 1.4 Intra cellular compartmentalization – Cytosol, mitochondria, chloroplast, endoplasmic reticulum, peroxisome, lysosomes, endosomes.
- 1.4.1 Transport of molecules between nucleus and cytosol. Transport into mitochondria and chloroplast, endocytosis and exocytosis
- 1.4.2 Protein sorting
- 1.5 Structure and functions of mitochondria
- 1.5 Structure and function of chloroplast
- 1.6 Multi drug resistant efflux forms

Credit 2 : Cell communication

- 2.1 Overview of extracellular signaling
 - 2.1.1 Basic characteristics of cell signaling systems - Paracrine, endocrine, autocrine signaling
- 2.2 Tight junctions and Gap junctions
- 2.3 Second messengers and their role in signal transduction
 - 2.3.1 Second messengers cAMP, lipid derived second messengers (phosphatidylinositol derived second messenger) & IP₃
 - 2.3.2 Role of calcium as second messenger
- 2.4 Cell surface receptors in signal transduction
 - 2.4.1 G-protein coupled receptor – structure and function
 - 2.4.2 Ion channel receptors
 - 2.4.3 Tyrosine kinase linked receptors
 - 2.4.4 Receptors with intrinsic enzyme activity (RTK)
- 2.5 Interaction and regulation of cell signaling pathways

Credit -3 : Cell Cycle and Cell Division

- 3.1 Components in cell cycle control - Cyclin, CDKs
- 3.2 Check points in cell cycle
- 3.3 Intracellular control of cell cycle events, phase dependent cyclic CDK complexes eg. yeast
- 3.4 Abnormalities in Cell Cycle – Cancer
- 3.5 Mechanics of Cell Division- An overview of M-Phase
- 3.6 Different stages of mitosis
- 3.7 Cohesins and Condensins in chromosome segregation
- 3.8 Microtubules in spindle assembly
- 3.9 Structure of kinetochore, centrosomes and its functions.
- 3.10 Sister Chromatid separation
- 3.11 Cytokinesis actin & myosin in the generation of contractile ring
- 3.12 Meiosis - Significance
- 3.13 Chiasma formation - Synaptonemal complex
- 3.14 Recombination during meiosis - Recombination nodules

Credit - 4 Cell Death Pathway

- 4.1 Introduction to Necrosis, Senescence, Apoptosis - Programmed cell death
- 4.2 Mechanisms of apoptosis
 - 4.2.1 Apoptosis triggered by internal signals
 - 4.2.2 Apoptosis triggered by external signals
 - 4.2.3 Apoptosis inducing factor
- 4.3 Apoptosis in cancer, immune system, organ transplants
- 4.4 Apoptosis in plants

M.Sc Biotechnology - BT103 U - Biochemistry

Credit 1: Chemistry of Biomolecules

1.1 Carbohydrates

1.1.1 Classification, structure, configuration, conformation and reactions of monosaccharides.

1.1.2 Stability, formation of glycosidic bond, disaccharides & oligosaccharides.

1.1.3 Polysaccharides: structural (cellulose, chitin) storage (starch, glycogen, insulin). Hemicelluloses - lignins, pectins, Glycoso-amino-glycan (hetero-polysaccharides / acidic muco-polysaccharides)

1.1.4 Chemistry & biological role of hyaluronic acid, chondroitin sulphate, keratin sulphate & dermatan sulphate.

1.1.5 Structural determination of polysaccharides. Blood group substances, glycoproteins, proteoglycans & bacterial cell wall polysaccharides (peptidoglycans).

1.2 Amino Acids & Proteins:

1.2.1 Classification, structure & characteristics of amino acids. Essential & Non essential amino acids.

1.2.2 Acid-base properties and general reactions of amino acids. Nonprotein or unusual amino acids.

1.2.3 Peptide bond stability & formation. Polypeptides. Methods for determining Molecular weight, Amino- & - Carboxyl termini.

1.2.4 Structural organization of proteins – primary, secondary, tertiary, quaternary and subunit structure of protein, Conformation of proteins Ramchandran's plot. Denaturation and Renaturation, Classification of proteins.

Credit 2: Chemistry of Biomolecules - II

2.1 Nucleic Acids:

2.1.1 Structure of purines, pyrimidines, nucleosides and nucleotides. Stability & formation of phosphodiester bond.

2.1.2 Watson & Crick model of DNA, Different forms of DNA. Circular DNA & super coiling. Types of RNA. Structure of t-RNA. Denaturation & renaturation of DNA - Melting Curves. Calculation of T_m for oligonucleotides and DNA. Chemical and Enzymatic susceptibility of Nucleic acids.

2.2 Lipids & Porphyrins

2.2.1 Structure, properties & classification of lipids, fatty acids, waxes, phospholipids, cerebrosides, lipoproteins and gangliosides. Prostaglandins - prostacyclins, leukotrienes, thromboxanes and physiological implications.

2.2.2 Steroids and bile acids. Structure / function of heme & chlorophyll.

Credit 3: Bioenergetics

3.1 Law of thermodynamics,

3.1.1 Biological oxidation,

3.1.2 Gibbs energy, free energy changes redox potential & phosphate potential. High energy compounds.

3.2 Glycolytic Pathway.

3.2.1 TCA Cycle

3.2.2 Oxidative Phosphorylation

3.2.3 Photophosphorylation, Electron Transport Chain

3.3 Glyoxylate Cycle

3.3.1 Pentose Phosphate Pathway

3.3.2 Gluconeogenesis

3.4 Photosynthesis -Photosystems

3.4.1 Light & Dark Phases

3.4.2 C3 & C4 and CAM Pathways

3.4.3 Bioluminescence

3.5 Fatty acid Metabolism - β - Oxidation of fatty acids

Credit 4: Enzymology

4.1 Basic Enzymology

4.1.1 Properties of enzymes: Protein conformation & catalyses, assays, units, specific activity, isolation methods & purifications. Metals & cofactors, Catalytic RNA.

4.1.2 Laws of thermodynamics: Entropy, K_{eq} , Gibbs free energy, and energy of activation, Activated substrate, catalytic efficiency, Nomenclature & classification of enzymes, introduction to enzyme regulation, allosteric & cooperative interactions.

4.2.1 Factors affecting the rate of the reaction:

4.2.2 Effect of enzyme concentration, varying substrates, single substrate reaction,

4.2.3 Briggs - Haldane equation, steady state assumptions, derivation & relationship of K_m & V_{max} . PH, temperature & pressure. Bisubstrate reactions:

4.2.4 Transformations of Michaelis-Menton equation, Reaction mechanisms & distinction between ordered & random addition of substrates & products release, use of inhibitors,

4.2.5 Derivations for inhibition & activation & types of inhibitions deviations form Michaelis- Menton Kinetics :

4.2.6 Binding isotherms & transformation to Hill equation, cooperativity, Multiple sites on an enzyme.

M.Sc Biotechnology - BT104 U - Communication Skills, Computer Basics, Cyber Crime

Credit -1 . Communication Skills

- 1.1 Spoken Skills : Telephonic communication –Group discussions – Presentation skills (Presentation of text/ Organisation/ Power point presentations/Use of charts and other presentation skills)
- 1.2 Written Skills : Business letters – Resume –Covering letter- Report writing- Scientific Writing
- 1.3 Grammar and vocabulary : Development of Vocabulary – Remedial Grammar (Concord, Tenses, Prepositions)

Credit -2 Basics of Computers

- 1.1 Computer Software and Hardware
- 1.2 Central Processing Unit (CPU)
- 1.3 Disk, CD, Key Board, Monitor, Mouse
- 1.4 Arithmetic Logic Unit
- 2 Basics of DOS and DOS Commands
- 2.1 Input, Output Devices

Credit - 3 Internet Browsing

- 3.1 Basics of Internet Browsing
- 3.2 Web Browsing
- 3.2 Basics of HTML
- 3.3 Basics of MS Office, Power Point Presentations
- 3.4 File Transfer Protocol
- 3.5 Applications of Computers in Biology

Credit 4 Cyber Crime

- 4.1 Computer related frauds, Computer forgery, Unauthorized access & interception Hacking, Alteration of computer data, Logic Bomb, Virus, Programme manipulations
- 4.2 Software piracy, Theft of trade secrets, Investigation of computer crime from seized material, Preparing & presenting the evidence, Information security and crime prevention, technical devices and techniques for prevention of cyber crime.

M.Sc Biotechnology - BT151 U - Genetics

Practicals

1. Monohybrid and dihybrid ratios ,Multiple alleles ,Epistasis - Problems
2. Quantitative Inheritance – Problems
3. Inheritance patterns in Man – Pedigree analysis
4. Preparation of polytene chromosomes
5. Localization of genes – two & three point test crosses – Problems
6. Tetrad analysis - Problems
7. Localisation of genes in man by sib pair method & Lod score estimations - Problems, Multipoint analysis- determining flanking loci
8. Gene mapping by Transmission disequilibrium test (TDT) - Problems

Books Recommended:

1. An introduction to Genetic Analysis by Anthony, J.F. J.A. Miller, D.T. Suzuki, R.C. Richard Lewontin, W.M- Gilbert, W.H. Freeman publication, 1998.
2. Principles of Genetics by E.J.Gardner and D.P. Snusted. John Wiley & Sons, New York 7th edition 1984.
3. The science of Genetics, by A.G. Atherly J.R. Girton, J.F. McDonald, Saundern College publication, 1999.
4. Principles of Genetics by R.H. Tamarin, International edtn McGrawhill - 1996
5. Theory & problems in Genetics by Stansfield, Schaum out line series McGrawhill –2000

M.Sc Biotechnology - BT152 U - Cell Biology

Practicals

1. karyotyping of normal & abnormal chromosome sets
2. Preparation of mitotic & meiotic chromosomes
3. Isolation of Mitochondria
4. Isolation of Chloroplast
5. Cell Cycle Synchronization
6. Estimation of Na⁺ K⁺ ATPase in Red Blood Cells
7. Determination of activity of Proton , Na , Antiport from Plant Cels

Books Recommended:

1. Cell & Molecular Biology . E.D.D De Robertis & E.M.F De Robertis, waverly publication.
2. Molecular Biology of the cell. Alberts, B; Bray, D, Lews, J., Raff, M., Roberts, K and Watson, J.D. 1991 3rd edn. Garland publishers, Oxford

M.Sc Biotechnology - BT153 U - Biochemistry

Practicals

1. Safety & Good Lab Practices:

Safety, care and precautions in Handling Hazardous Chemicals and disposal of waste, Material Safety Data Sheet, Laboratory observation Notebook

Standard units to express concentrations. Biochemical Calculations and Statistical Analysis of Data Preparation and Storage of solutions. Storage of general chemicals, toxic chemicals, organic solvents, fine and labile chemicals and biological material, blood and serum.

2. Buffers and Spectrophotometry:

Standard Solutions, Concept of Primary and Secondary Standards: Henderson- Hasselbach Equation. Preparation of Buffers (acidic, basic, neutral, biological) Titration Curves for amino acid: determination pKa and pI; Absorption spectra (Max) of Protein, Nucleic Acid, Aromatic Amino Acid and riboflavin. Care in handling Instruments (pH-meter, Spectrophotometer, centrifuges, colorimeter, analytical balance etc) Verification of Beer-Lamberts Law and its deviation. Determination of molar extinction coefficient (NADH\Tyrosine\ Adenine).

3. Qualitative and Quantitative Analysis:

Identification of amino acids and proteins by color reactions;

Determination of Glycine (Sorensen formal titration), amino acid by ninhydrin method,

Determination of Protein (Biuret and Folin's Method).

Identification of Carbohydrates and Lipids

Titrimetric determination of sugars by Benedict's, Total sugars by Anthrone, and DNS Methods. Reducing and non-reducing sugars.

Determination of aldose and ketose sugars. Determination of acid value, saponification and Iodine number of oils and fats.

4. Chromatographic methods:

Paper chromatography of carbohydrates, amino acids, purines and pyrimidines.

2D paper chromatography,

TLC of fatty acids/lipids.

Paper electrophoresis of amino acids.

Cellulose acetate electrophoresis of serum proteins,

Column Chromatography; Ion Exchange Chromatography - Determination of exchange capacity of resins (titric method)

Identification of ion exchange resins.

Separation of amino acids by Dowex - 50: Gel Filtration: Determination V_o separation of Blue Dextran and Cobalt chloride or Protein and amino acid by Sephadex-G10.

M.Sc Biotechnology - Semester - II

Theory Papers

BT201 U - Microbiology

BT202 U - Molecular Biology - 1

BT203 U - Molecular Biology - II

BT204 U - Statistics, Standards and Quality Management, Laboratory Management & Safety

Practical Papers

BT251 U - Microbiology

BT252 U - Molecular Biology - 1

BT253 U - Molecular Biology – II

M.Sc Biotechnology - BT201 U - Microbiology

Credit 1: General characters of microorganisms

- 1.1 Historical developments in Microbial Biotechnology
- 1.2 The concept of Microbial origin of Fermentations
- 1.3 Microscopy and microscopic observation of Microorganisms
- 1.4 Structure and general characters of Bacteria, Archaea, Fungi and Algae
- 1.5 Identification methods of bacteria and other microorganisms
- 1.6 Fundamentals of classification of Classification of Bacteria, Fungi and Algae

Credit 2: Viruses and their characters

- 2.1 General characters of viruses
- 2.2 Structure and replication of Bacteriophage (T2), Lambda
- 2.3 Retroviruses, TMV, HIV, SV40, Prions - Kuru
- 2.4 Classification of viruses and important characters of each group
- 2.5 Methods of cultivation of viruses
- 2.6 Importance of viruses in biotechnology

Credit 3: Microbiological techniques

- 3.1 Concept of sterilization
- 3.2 Methods of sterilization and their application in industry
- 3.3 Concept of pure culture and methods of pure culture development
- 3.4 Methods of preservation of microbial cultures of industrial application
- 3.5 Methods of measurement of growth

Credit 4: Microbial physiology and growth

- 4.1 Nutrition in Microorganisms and assimilation of nutrients
- 4.2 Nutritional groups of microorganisms and their importance in fermentation industry
- 4.3 Microbiological media and their application
- 4.4 Culturing of microorganisms
- 4.5 Methods of microbial culturing in laboratory and industry
- 4.6 Microbial growth and growth curve
- 4.7 Exponential growth and synchronous growth

M.Sc Biotechnology - BT202 U - Molecular Biology - 1

Credit 1: Genetic Material and Genome Replication

- 1.1. DNA as genetic material – Experiments of Griffith, Avery et al and Hershey & Chase
- 1.2. RNA as genetic material – TMV
- 1.3. Enzymes involved in the replication of DNA and their features
- 1.4. Replication of DNA – Semi conservative replication. Meselson and Stahl's experiment
- 1.5. Replication of circular and linear DNA
- 1.6. Maintenance of ends of linear DNA molecules
- 1.7. Regulation of eukaryotic genome replication

Credit 2: DNA Damage and repair

- 2.1. Spontaneous and Induced mutations – Physical and Chemical mutagenesis
- 2.2. Molecular mechanisms of mutagenesis – Transition, Transversion, Frame Shifts, mis-sense and non-sense mutations
- 2.3. Photo-reactivation
- 2.4. Excision Repair
- 2.5. Mismatch Repair
- 2.6. Post-replication Repair
- 2.7. SOS Repair

Credit 3: Recombination in bacteria and viruses

- 3.1 Transformation : Competence factors, mechanism of transformation, mapping genes by transformation
- 3.2 Conjugation
 - 3.2.1 Structure of F plasmid, Mechanism of transfer of F plasmid
 - 3.2.2 Hfr, mechanism of integration of F plasmid into bacterial chromosome circularization of chromosome.
 - 3.2.3 Conjugation mapping – different methods
- 3.3 Transduction
 - 3.3.1 Generalised transduction, lysogeny and lytic cycle
 - 3.3.2 Specialised transduction – structure of λ phage, mechanism of integration λ bio λ dgal
 - 3.3.3 Gene mapping by transduction

Credit 4: Genome Rearrangements and Recombination

- 4.1. Complete and Segmental Duplication of Genomes
- 4.2. Insertion, Deletion and Translocation of Sequences
- 4.3. Process of Rearrangements
 - 4.3.1. Homologous Recombination – rec Pathways
 - 4.3.2. Site specific Recombination
 - 4.3.3. Non-homologous End Joining
- 4.4. Transposon and Repeats mediated Rearrangements
- 4.5. Molecular mechanisms of Gene Conversion

M.Sc Biotechnology - BT203 U - Molecular Biology - II

Credit 1 : Genome organization

- 1.1 General features of prokaryotic genome organization
- 1.2 Organization of Prokaryotic genes
- 1.3 Organization of eukaryotic genome
- 1.4 Genome size, c-value paradox
 - 1.4.1 Kinetics of DNA re-association
 - 1.4.1 Kinetic classes – unique sequence
 - 1.4.2 Repeated sequences - moderate and highly repetitive sequences, Palindromes
- 1.5 Satellite DNA
- 1.6 Special features of eukaryotic genes – gene structure and organization
- 1.7 Gene clusters and gene families – Immunoglobulin gene cluster, Globin gene family
- 1.8 Organization of mitochondrial genome
- 1.9 Organization of chloroplast genome

Credit 2 : Transcription

- 2.1 Mechanism of transcription in prokaryotes
 - 2.1.1 Initiation
 - 2.1.2 Elongation
 - 2.1.3 Termination
- 2.2 Mechanism of transcription in eukaryotes
 - 2.1.1 Eukaryotic RNA polymerases
 - 2.1.2 Transcription factors
 - 2.1.3 Transcription activators- zinc fingerprints
 - 2.1.4 HAL4, Homeodomain
 - 2.1.5 Enhancers and mediators
- 2.3 Post transcriptional events
 - 2.3.1 Splicing mechanism- alternate splicing, trans splicing, self splicing, tRNA splicing
 - 2.3.2 Capping and polyadenylation

Credit 3 : Genetic Code and Translation

- 3.1 Correspondance of amino acid sequence in proteins with nucleotide sequence in DNA, single letter codes for amino acids
- 3.2 Properties of genetic code- universal code, degeneracy and redundancy
- 3.3 Mechanism of translation, assembly of ribosomal subunits, t-RNA structure
- 3.4 Peptide chain formation
- 3.5 Post translational modifications

Credit 4 : Regulation of Gene expression

- 4.1 Co-ordinated Regulation of gene expression in Prokaryotes
 - 4.1.1 Regulation of lactose operon
 - 4.1.2 Regulation of Tryptophan operon
- 4.2 Regulation of Gene expression in Eukaryotes
 - 4.2.1 Genes controlling yeast mating type
 - 4.2.2 Regulation of Xenopus 5S rRNA in oocytes
 - 4.2.3 Using a strategically placed enhancer as genetic switch – chicken globin genes
 - 4.2.4 Gene regulation exerted at the level of translation – silk fibroin gene
 - 4.2.5 Regulation at splice site selection – Drosophila sex determination

M.Sc Biotechnology - BT204 U - Statistics, Standards and Quality Management, Laboratory Management & Safety

Credit 1 Descriptive Statistics & Probability Distribution

- 1.1 Sampling - Sampling procedure, homogenization of samples, samples size, Selection of random sample, Limitation of analytical methods, classification of errors, measurement of averages and variation, minimization of errors.
- 1.2 Types of data, Frequency distribution, Measure of central values - Mean, median and mode, Measures of dispersion - range, mean deviation, standard deviation, coefficient of variation, moment, Skewness and kurtosis,
- 1.3 Graphical representation of Data, Histogram, Frequency polygon, Pie Chart
- 1.4 Probability, Concept of Probability Theory, Events, Trials, Mutually exclusive events, favorable events, exhaustive events, Bayesian theorem of Probability, Addition theorem, Multiplication theorem
- 1.5 Binomial distribution, Normal distribution, Poisson distribution & their applications.
- 1.6 Discriminating power, Derivation, Evaluation of evidence by discriminating powers.
- 1.7 Combination of independent systems, Correlated attributes, transfer of evidence, Likelihood ratio

Credit - 2 Statistical Inference of Qualitative & Quantitative Variables

- 2.1 Concept of Test of hypothesis, Null & Alternative hypothesis, level of significance
 - 2.1.1 Chi square test & its applications,
 - 2.1.2 Large Sample Tests- Z-test of Means & Proportions
 - 2.1.3 Small sample test - T-test for Means, Paired T-test,
- 2.2 Analysis of variance and Co-variance
- 2.3 One-Way ANOVA, Two way ANOVA, F-test
- 2.4 Simple regression and correlation
- 2.5 Test of regression coefficient and correlation Coefficient

Credit 3 : Standards for analysis & Quality management

- 3.1 Basic standards, Need of standards in analytical sciences
- 3.2 Analytical standards- Reference materials/controls (positive & negative), High purity substances, certified reference material
- 3.3 Working or secondary standards, matrix effect in standards
- 3.4 Biological standards, Biochemical standards, Microbial cell lines and standards
- 3.5 Quality Management - Quality system, Inspection and testing, Handling, Storage, Packaging, Preservation of the material, Internal quality audits, Quality assurance.
- 3.6 Laboratory Accreditation, Accreditation Boards, NABL guidelines for accreditation in India
- 3.7 Proficiency testing system, Internal quality control, Inter and intra laboratory testing programmes, Advantages of accreditation.

Credit 4 : Laboratory Management & Safety :

- 4.1 Administration of Laboratories, Laboratory design, Security measures, Laboratory Information management system (LIMS)
- 4.2 Laboratory safety – Safety policies
- 4.3 Operation Hazardous compound - chemicals, solvents, poisons, isotopes, explosives and Biological strains (Bacterial, fungal etc)
- 4.4 Storage of hazardous material and disposal of biological and radioisotope wastes

M.Sc Biotechnology - BT251 U - Microbiology

Practicals

1. Microscopic observation, Staining and identification of bacteria, fungi and algae
2. Preparation of routine microbiological media
3. Sterilization methods (Autoclaving, Hot air oven, radiation and filtration)
4. Isolation of bacteria, fungi and algae
5. Isolation of bacteriophages
6. Preservation and maintenance of microbial cultures
7. Culturing of microorganisms: Tube culture (slant/broth), plate culture, flask culture
8. Measurement of microbial growth (Viable count and turbidometry)
9. Study for bacterial growth curve

Books Recommended:

1. Microbiology by M.J. Pelzar, E.S.N. Cfan and N.R. Kreig, McGraw Hill Publ.
2. Introductory Microbiology by J. Heritage, E.G.V. Erans, R.A. Killington, Cambridge University Press.
3. General Microbiology by H.G. Schlegel Cambridge University Press.
4. General Microbiology by Stanier, R.Y, J.L. Ingrahm, M.L. Wheel is & P.R. Painter.
5. Microbiology – concepts and Application. John Wiley and Sons, New York, 1988.

M.Sc Biotechnology - BT252 U - Molecular Biology - 1

Practicals

1. Isolation of plasmid DNA
2. Isolation of DNA from Plant Cells
3. Isolation of DNA from Human whole blood
4. Determination of purity and concentration of DNA - Spectrophotometric method
5. Isolation of mRNA
6. Induction of mutations by chemical agents
7. Determination of DNA damage by comet assay

References

1. Molecular Biology of the Gene by J.D. Watson, N.H. Hopkins, J.W, Robertis , A. Steitz & A.M. Weiner, Benjamin Cummings Publ. California - 1988
2. Genes VII. Benjamin Lewin, Oxford Univ. Press, Oxford (2000)
3. Molecular Biology by D, Freifelder Narosa Publishing house New York, Delhi, 1987.
4. Molecular Cell Biology Lodish, H., Baltimore, D; fesk, A., Zipursky S.L., Matsudaride, P. and Darnel 4th edn. American Scientific Books. W.H. Freeman, NewYork (2000).
5. Advance Molecular Biology Twyman, R.M., Bios Scientific publishers Oxford 1998.
6. Molecular Biology by Brown, 3rd edition.
7. Essentials of Molecular Biology. D. Freifelder, Panima publishing corporation.

M.Sc Biotechnology - BT253 U - Molecular Biology - II

Practicals

Methods in Molecular Biology - II

1. Determining melting temperature of DNA
2. Reassociation Kinetics and estimation of cot values, construction of cot curves
3. Screening for hot Spot mutations in Mitochondrial DNA
4. Gene Expression at m-RNA level by RT PCR/real time PCR
5. Expression of globulin genes

References

1. Molecular Biology of the Gene by J.D. Watson, N.H. Hopkins, J.W, Robertis , A. Steitz & A.M. Weiner, Benjamin Cummings Publ. California - 1988
2. Genes VII. Benjamin Lewin, Oxford Univ. Press, Oxford (2000)
3. Molecular Biology by D, Freifelder Narosa Publishing house New York, Delhi, 1987.
4. Molecular Cell Biology Lodish, H., Baltimore, D; fesk, A., Zipursky S.L., Matsudaride, P. and Darnel 4th edn. American Scientific Books. W.H. Freeman, NewYork (2000).
5. Advance Molecular Biology Twyman, R.M., Bios Scientific publishers Oxford 1998.
6. Molecular Biology by Brown, 3rd edition.
7. Essentials of Molecular Biology. D. Freifelder, Panima publishing corporation.

M.Sc Biotechnology - Semester - III

Theory Papers

BT301 U - r-DNA Technology

BT302 U - Industrial Biotechnology

BT303 U - Immunology

BT304 U - Intellectual Property Rights, Entrepreneurship, Ethics & Research Methodology

Practical Papers

BT351 U - r-DNA Technology

BT352 U - Industrial Biotechnology

BT353 U – Immunology

M.Sc Biotechnology - BT301 U - r-DNA Technology

Credit I Enzymes and vectors used in molecular cloning

- 1.1 Discovery of restriction enzymes - Host controlled modification
- 1.2 Restriction endonucleases and classification
- 1.3 Modifying enzymes used in molecular cloning; methylases, polymerases, ligases, kinases, phosphatases, nucleases, RNA dependent DNA polymerase, Terminal Deoxynucleotidyl transferase
- 1.4 E.Coli plasmid vectors – pBR322, pUC18, pET21
- 1.5 Bacterio-phage vectors – λ and M13
- 1.6 Cosmids, phagemids and Phasmids
- 1.7 Shuttle vectors - Yeast vectors,
- 1.8 Baculo virus vector

Credit II Construction of Genomic and cDNA Libraries

- 2.1 DNA cloning
 - 2.2 Strategies for construction of genomic libraries, jumping and linking libraries, chromosome walking
 - 2.3 Strategies for construction of cDNA libraries, subtraction libraries, normalized libraries
- Credit III Techniques employed in molecular cloning

- 3.1 Labeling of Nucleic acids and proteins
- 3.2 Blotting and Hybridization techniques - Southern, Northern, Western, North- Western and Zoo blots and Colony hybridization
- 3.3 DNA sequencing – Maxam and Gilbert method and Sanger's method
- 3.4 PCR technology and its applications

Credit IV Selection and Analysis of recombinant Clones

- 4.1 Genetic selection – alpha complementation, insertional inactivation
- 4.2 Screening of libraries using labeled probes
- 4.3 Restriction mapping of cloned fragments
- 4.4 S1 Nuclease Mapping
- 4.5 Hybrid arrest and hybrid released translation
- 4.6 Site directed mutagenesis
- 4.7 Factors influencing cloned gene expression
- 4.8 Applications of rDNA technology

M.Sc Biotechnology - BT302 U - Industrial Biotechnology

Credit I Selection of Industrial Microorganisms

- 1.1 Industrial cultures – Bacteria, Algae, Fungi, Actinomycetes
- 1.2 Primary and secondary screening of microorganisms for industrial products
- 1.3 Isolation and preservation of microorganisms for industrial products
- 1.4 Strain development – mutation, selection & recombination

Credit II Fermentation Process

- 2.1 Fermentation design – overview of aerobic & anaerobic fermentation process
- 2.2 Fermentor systems – types
- 2.3 Fermentation process and factors affecting fermentation process
- 2.4 Design of Fermentation media
- 2.5 Substrates used as Carbon and nitrogen sources

Credit III Production of microbial products

- 3.1 Organic acids – citric acid, lactic acid, acetic acid & gluconic acid
- 3.2 Amino acids – glutamic acid, lysine & aspartic acid
- 3.3 Alcohols & beverages – ethanol, acetone – butanol, beer, wine
- 3.4 Enzymes – proteases, amylases, lipases, cellulases & pectinases
- 3.5 Enzyme Biosensors – application in industry, health care & environment

Credit IV Health Care Products and Food Additives

- 4.1 Antibiotics – penicillin, streptomycin & erythromycin
- 4.2 Vaccines – BCG, hepatitis-B & recombinant vaccines
- 4.3 Vitamins – B₁₂, D & C
- 4.4 Dairy products – cheese, yoghurt & other products

M.Sc Biotechnology - BT303 U - Immunology

Credit I Basics of Immunology

- 1.1 Immunity – Types of Immunity, Innate and Acquired Immunity
- 1.2 Cells of the Immune System – B & T Lymphocytes; T-cell sub-sets; The Antigen Presenting Cells
- 1.3 Organs of the System : Primary lymphoid organs (Bone marrow and Thymus); Secondary lymphoid organs (lymph nodes, spleen and mucosal-associated lymphoid tissue)
- 1.4 Antigens - Immunogenicity versus Antigenicity, Factors that influence immunogenicity, Epitopes - Properties of B-cell epitopes and T-cell epitopes, Haptens and the study of Antigenicity

Credit II Immunoglobulins : Structure and Functions

- 2.1 Basic structure of Immunoglobulins - The role of multiple myeloma in understanding Ig structure
- 2.2 Fine structure of Immunoglobulins - Immunoglobulin domains-variable region and constant region domains
- 2.3 Immunoglobulin classes - IgG, IgM, IgA, IgD and IgE; functions of Ig classes
- 2.4 Organization and expression of Immunoglobulin Light and Heavy chain genes
- 2.5 Monoclonal Antibodies - Formation and selection of hybrid cells; Production of Monoclonal Antibodies and their clinical uses

Credit III Major Histocompatibility Complex (MHC)

- 3.1 General organization and inheritance of MHC; MHC Haplotypes
- 3.2 The structure of MHC class-I and class-II molecules; organization of MHC class I and class II genes, peptide binding of MHC molecules
- 3.3 Polymorphism of MHC class I and class II molecules; the role of HLA typing in organ transplantation
- 3.4 Cellular distribution of MHC molecules; MHC molecules and immune responsiveness

Credit IV The Humoral and Cell-mediated Immune Responses

- 4.1 Antigen processing by antigen-presenting cells
- 4.2 The structure and functions of T-cell receptors (TCR); the TCR-peptide-MHC tri-molecular complexes
- 4.3 B-cell activation and proliferation by Thymus independent and Thymus dependant antigens; in vivo sites for induction of humoral response; B-cell differentiation, class-switching and generation of plasma cells and memory cells
- 4.4 Cell-mediated immune response: General properties of effector T-cells; Direct cytotoxic response; experimental assessment of cell-mediated cytotoxicity; Delayed type of hypersensitivity (DTH) and cytokines involved in DTH
- 4.5 Auto-immunity and auto-immune diseases-Insulin Dependant Diabetes; Rheumatoid Arthritis and Auto-immune Thyroid disease

M.Sc Biotechnology - BT304 U - Intellectual Property Rights, Entrepreneurship, Ethics & Research Methodology

Credit 1 Intellectual property rights

- 1.1 Intellectual property rights: Meaning,-Evolution – Classification and forms
- 1.2 Rationale for protection of IPRs – Importance of IPRs in the fields of science and technology
- 1.3 Patents – Concepts and principles of patenting – Patentable subject matter
- 1.4 Procedure of obtaining patents – Rights of patents – Infringement of patent rights
- 1.5 Remedies for infringement of patent rights – Patentability and emerging issues

Credit 2 Entrepreneurship

- 2.1 Concept, definition, structure and theories of entrepreneurship
- 2.2 Types of start-ups
- 2.3 Types of entrepreneurship, environment, process of entrepreneurial development,
- 2.4 entrepreneurial culture, entrepreneurial leadership,
- 2.2 Product planning and development
 - 2.2.1 Project management
 - 2.2.2 Search for business idea
 - 2.2.3 Cocept of projects
 - 2.2.4 Project identification, formulation
 - 2.2.5 Design and network analysis
 - 2.2.6 Project report and project appraisal

Credit 3 Ethical Issues

- 3.1 Introduction – causes of unethical acts, ignorance of laws, codes, policies and Procedures, recognition, friendship, personal gains
- 3.2 Professional ethics – professional conduct
- 3.3 Ethical decision making, ethical dilemmas
- 3.4 Teaching ethical vaues to scientists, good laboratory practices, good manufacturing practices, laboratory accreditation

Credit 4 Research methodology

- 4.1 Introduction- Basic research, applied research, need based research
- 4.2 Identification of the problem, defining the problem
- 4.3 Research project planning
 - 4.3.1 Literature search – information sources, library resources- books, journals, abstracts hand books, procedure manuals, encyclopedias, annual reports, data banks, CDROMS, online literature search – internet access, websites, directories of information resources
 - 4.3.2 Design of the experimental programme – variables in the experiments, materials and methods, evolution of methods, application of methods
 - 4.3.2 Progress of research – evauation of results, statistical approach, comparison with existing methodologies, validation of findings, research communications, impact factor of journals

M.Sc Biotechnology - BT351 U - r-DNA Technology

Practicals

1. Amplification of genomic DNA by PCR technique
2. Restriction digestion of genomic or lambda DNA and size determination of the fragments
3. Double digestion of DNA and restriction mapping, problems on restriction mapping
4. Cloning of foreign DNA fragments into E. coli/ yeast
5. Selection of recombinant clones by alpha complementation / insertional inactivation
6. Analysis of recombinant clones
7. Expression of foreign protein in heterologous host
8. PCR based site directed mutagenesis

References:

1. Molecular Biology of the gene by J. Watson
2. Genes Vol VI, VII and VIII by Benjamin Lewin
3. Molecular Biotechnology Principles and application of recombinant DNA
4. Principles of Gene manipulation by R.W. Old and S.B. Primrose
5. Molecular Biology by Robert F. Weaver
6. Recombinant DNA: A short course by J. Watson, Tooze and Kurtz
7. Molecular Biology by J. Watson

M.Sc Biotechnology - BT352 U - Industrial Biotechnonology

Practicals

1. Production of organic acids - Citric acid production & estimation
2. Production of alcohol - Alcohol production & estimation
3. Screening for amylase producing organisms
4. Production and assay of amylase activity

References

1. Comprehensive Biotechnology Vol. 1-4 : M.Y. Young (Eds.), Pergamon Press
2. Biotechnology- A Text Book of industrial microbiology, T.D. Brock, Smaeur Associates 1990
3. Industrial Microbiology : L.E. Casida, Willey Eastern ltd., 1989
4. Industrial Microbiology : Prescott & Dunn, CBS Publishers, 1987
5. Bioprocess technology – Fundamentals & applications, S.O. Enfors & L.Hagstrom (1992), RIT, Stockholm
6. Biotechnology, Economic & Social Aspects : E. J. Dasilva, C. Ratledge & A. Sasson, Cambridge Univ. Press
7. Biotechnology – Handbook of Industrial microbiology : W. Crueger & A. Crueger
8. Microbial Biotechnology : A. N. Glazer and H. Nikaido

M.Sc Biotechnology - BT353 U - Immunology

Practicals

1. Micro-hemagglutination Test
2. Single Radial Immunodiffusion
3. Enzyme-Linked Immuno-sorbent Assay
4. Cell-viability Test by Trypan Blue
5. Differentiation of titers of Rheumatoid Arthritis
6. Principle and procedure for Enumeration of specific blood types by FACS (Florescent Activated Cell Sorter)
7. Demonstration of Western Blot by Enzyme-conjugated antibody

M.Sc Biotechnology - Semester - IV

Theory Papers

BT401 U - Bioinformatics

BT402 U - Bioprocess Engineering

Elective

BT403a U - Medical Biotechnology

BT403b U - Animal Biotechnology

BT403c U - Agriculture Biotechnology

BT403d U - Environmental Biotechnology

Practical Papers

BT451 U - Bioinformatics

BT452 U - Bioprocess Engineering

Elective

BT453a U - Medical Biotechnology

BT453b U - Animal Biotechnology

BT453c U - Agriculture Biotechnology

BT453d U - Environmental Biotechnology

M.Sc Biotechnology - BT401 U - Bioinformatics

Credit 1: Foundations to Bioinformatics

- 1.1 Foundations to bioinformatics – Evolution, similar macromolecular components, constancy of gene number and core proteome in closely related organisms
- 1.2 Bioinformatics data – nucleic acid sequence, protein sequence, protein structure, genomic, proteomic and metabolomic information
- 1.3 Bioinformatics databases – types, design, file formats, access tools with examples
- 1.4 Bioinformatics tools and Resources – free online tools, downloadable free tools, software packages, internet, Bioinformatics books and Journals, Bioinformatics web- portals

Credit 2: Comparison methods in bioinformatics

- 2.5 Dot-matrix comparison
- 2.6 Basics of sequence alignment - match, mismatch, gaps, scoring alignments, gap penalty, protein vs DNA alignment
- 2.7 Pairwise alignment algorithms – Needleman and Wunch algorithm, Smith Watermann algorithm
- 2.8 Multiple sequence alignment algorithms – progressive alignment algorithms, Iterative alignment algorithms
- 2.9 Pair wise alignment based heuristic algorithms - Blast algorithm, FASTA algorithm
- 2.10. Multiple sequence alignment based databases searching: Consensus sequence, patterns, profiles
- 2.11 PAM and BLOSUM matrices

Credit 3: Genomic and Proteomic Application of Bioinformatics

- 3.1 Bioinformatics for genome sequencing
- 3.2 EST Clustering and analyses
- 3.3 Finding genes in prokaryotic and eukaryotic genomes: open reading frames, contents, signals
- 3.3 Regulatory sequence analysis: core and distal promoter sequences, transcription factor binding sites
- 3.4 Bioinformatics for Genome maps and markers
- 3.5 Bioinformatics for understanding Genome variation
- 3.6 Protein structure prediction and classification
- 3.7 Bioinformatics in support of Proteomic research

Credit - 4: Applications of Bioinformatics

- 4.1 Medical application of Bioinformatics – disease genes, drug targets, pharmacogenomics, drug designing
- 4.2 Structural biology - Homology modeling
- 4.3 Bioinformatics for micro array designing and transcriptional profiling
- 4.4 Bioinformatics for metabolic reconstruction
- 4.5 Bioinformatics for phylogenetic analysis

M.Sc Biotechnology - BT402 U - Bioprocess Engineering

Credit 1: Fundamentals of Bioprocess Engineering

1.1 Introduction to bioprocess engineering

1.2 Bioprocess kinetics : Quantitative description of cellular process, Kinetic modeling, Model structures

1.3 Material balances and energy balances : Mass balances for ideal bioreactors

1.4 Cell immobilization, production of biomass and applications

Credit 2: Upstream process infrastructure and considerations

2.1 Designing of bioreactors: Bioreactor types, design configurations, design features, designs bioreactors for sterile operations

2.2 Transport phenomenon in bioprocess system: Mass transfer, heat transfer, Oxygen transfer, shear stress effects and energy inputs in bioreactors

2.3 Sterilization of media and air : Design of sterilization process (batch and continuous), sterilization of bioreactor, feed and liquid waste, sterilization of air, exhaust air, theory of depth filter, designing of depth filter

Credit 3: Downstream process and product recovery

3.1 Downstream processing: A multi stage operation

3.2 Unit operations: solid liquid separation: filtration, centrifugation, filter aids, flocculation, foam separation (theory and equipments)

3.3 Recovery of intracellular components: Mechanical and non-mechanical (chemical and enzymatic methods)

3.4 Concentration of biological products : Evaporation, liquid-liquid extraction,

3.5 aqueous two phase system (ATPS), membrane filtration, pervaporation, perstraction, precipitation, adsorption etc.

3.6 Purification of product: chromatography methods: Size exclusion chromatography, ion exchange, column-chromatography, chromato-focussing, hydrophobic interaction chromatography, affinity chromatography, immobilized ion metal chromatography, covalent chromatography.

3.7 Product formulation: Principles and equipments, crystallization, drying, use of different types of dryers and lyophilization. Monitoring of downstream process and process integration

Credit 4. Bioprocess control measurement and automation

4.1 Classes of sensors: In-line, on-line and off-line sensors

4.2 Physical and chemical sensors for media and gases: Instrumentation and principles for measurement of temperature, flow rate, pressure, agitation shaft power, foam sensing, biomass, dissolve oxygen, pH, carbon dioxide etc.

4.3 Automation and control system: manual control, automatic control, PID control and complex control systems.

4.4 Application of computers in bioprocess engineering: Data logging, analysis and control

4.5 Process economics : Cost benefit analysis

M.Sc Biotechnology - Elective - BT403a U - Medical Biotechnology

Credit I: Classification of genetic diseases

- 1.1 Chromosomal disorders – Numerical disorders e.g. trisomies & monosomies, Structural disorders e.g. deletions, duplications, translocations & inversions, Chromosomal instability syndromes
- 1.2 Gene controlled diseases – Autosomal and X-linked disorders, Mitochondrial disorders and Multifactorial conditions
- 1.3 Identification of disease genes
 - 1.3.1 Functional cloning –eg. haemophilia gene
 - 1.3.2 Positional cloning – eg. DMD and CGD genes
 - 1.3.3 Candidate gene approach – eg. Marfan's syndrome, Alzheimer's disease
- 1.4 Molecular basis of human diseases - Pathogenic mutations
 - 1.4.1 Gain of function mutations: Oncogenes, Huntingtons Disease, Pittsburg variant of alpha 1 antitrypsin.
 - 1.4.2 Loss of function - Tumour Suppressor Genes, PAX- 3 gene
 - 1.4.3 Gene Dosage Effect - PMP22 , Collagen gene
 - 1.4.4 Genomic Imprinting -Mechanisms, Praderwilli / Angelman syndrome, WAGR syndrome, Beckwith Weidemann Syndrome
 - 1.4.5 Dynamic Mutations - Fragile- X syndrome, Myotonic dystrophy
 - 1.4.6 Mitochondrial diseases: MELAS, LHON, MERRF
 - 1.4.7 Immuno Pathology, Hepatitis, HIV, Autoimmune Disorders-SLE, RA

Credit : II Diagnostics

- 2.1 Prenatal diagnosis - Invasive techniques - Amniocentesis, Fetoscopy, Chorionic Villi Sampling (CVS), Non-invasive techniques - Ultrasonography, X-ray, TIFA, maternal serum and fetal cells in maternal blood
- 2.2 Diagnosis using protein and enzyme markers, monoclonal antibodies.
- 2.3 DNA/RNA based diagnosis Hepatitis, CML – bcr/abl, HIV - CD 4 receptor
- 2.4 Microarray technology- genomic and c DNA arrays, application to diseases

Credit III : Therapeutics

- 3.1 Clinical management and Metabolic manipulation – PKU, Familial Hypercholesterolemia, Rickets, ADA, Congenital hypothyroidism.
- 3.2 Gene therapy - Ex-vivo, Invivo, Insitu gene therapy Strategies of gene therapy: gene augmentation – ADA deficiency, CFTR Prodrug therapy/ suicide gene – glioma, evoking immune response – melanoma TFO, Antisense therapy, Ribozymes, Protein Aptamers, Intrabodies
- 3.3 Vectors used in gene therapy Biological vectors – retrovirus, adenoviruses, Herpes Synthetic vectors– liposomes, receptor mediated gene transfer
- 3.5 Gene therapy trials – Familial Hypercholesterolemia, Cystic Fibrosis, Solid tumours.
- 3.6 Cell and tissue engineering: Encapsulation technology and therapeutics-Diabetes, Hypothyroidism, Haemophilia Bioartificial organs, Artificial Cells- For Haemophilia, Phenyl Ketonuria, Diabetes
- 3.7 Stem cell therapy - Embryonic and adult Stem Cells, Totipotent, Pluripotent and Multipotent Cells
 - 3.7.1 Testing and generation of embryonic stem cells,
 - 3.7.2 Testing for adult stem cells and differentiation
 - 3.7.3 Potential use of stem cells – Cell based therapies
- 3.8 Nanomedicine – Nanoparticles, Nanodevices-medical microrobotics, nanorobotics , Microbiovers, Nanomedicine and Nanosurgery – for cancers, neurological disorders.

Credit IV : Gene products in medicine

- 4.1 Functional cloning – anti-haemophilic factor
- 4.2 Positional cloning- Dystrophin
- 4.3 Gene products in medicine – Humulin,Erythropoietin, Growth Hormone/Somatostatin, tPA, Interferon
- 4.4 DNA based vaccines
 - subunit vaccines – Herpes Simplex Virus
 - Attenuated Vaccines– Cholera
 - Vector vaccines – Cholera and Salmonella

M.Sc Biotechnology - Elective - BT403b U - Animal Biotechnology

Unit I Animal Tissue Culture

- 1.1 Media for cultured cells & tissues – natural & defined media
- 1.2 Preparation of various tissue culture media, sterilization
- 1.3 Fibroblast culture from neonatal rat skin
- 1.4 Development & maintenance of cell lines
- 1.5 Cell hybridization, hybridoma & monoclonal antibodies production
- 1.6 In vitro culture of Oocyte / embryo
- 1.7 Cryopreservation of cell, embryo, ovum , semen
- 1.8 Stem cell – isolation & culture

Unit II Animal improvement

- 2.1 Conventional methods of animal Improvement – Selective Breeding, Cross Breeding
- 2.2 Embryo Biotechniques for augmentation of replication efficiency and faster multiplication of superior germplasm
- 2.3 Super ovulation, Oestrus Synchronization, embryo collection and transfer
- 2.4 In vitro maturation of oocytes, in vitro fertilization, embryo culture, preservation
- 2.5 Micromanipulation and cloning
- 2.6 Somatic cell cloning
- 2.7 Embryo sexing
- 2.8 Identification and isolation of gene of economic importance
- 2.9 Transgenesis for animal improvement and production of animals as bioreactors for proteins of pharmaceutical value
- 2.10 Gene mapping in farm animals
- 2.11 Marker assisted selection and genetic improvement of live stocks

Unit III Development and Use of Transgenic Animals

- 3.1 Transgenic mice - methodology
- 3.2 Retroviral Vector method
- 3.3 DNA microinjection method
- 3.4 Engineered embryonic stem cell method
- 3.5 Knocking in and knocking out of genes
- 3.6 Applications

Unit IV Vaccines and Therapeutic Agents

- 4.1 Sub-unit Vaccines
- 4.2 Live recombinant vaccines
- 4.3 Attenuated Vaccines
- 4.4 Anti-idiotipic vaccines
- 4.5 Monoclonal antibodies as therapeutic agents (transplant rejection)
- 4.6 Genetically engineered Immunotherapeutic agents

M.Sc Biotechnology - Elective - BT403c U - Agriculture Biotechnology

Credit I Clonal Propagation of Plants

- 1.1 Introduction to totipotency of Plant cells
- 1.2 Initiation of Callus and suspension cultures
- 1.3 Micropropagation of ornamental and horticultural plants and forest trees via organogenesis and embryogenesis
- 1.4 Encapsulation and production of synthetic seeds
- 1.5 Embryo culture and embryo rescue
- 1.6 Protoplast culture and fusion. Development of somatic hybrids to overcome the incompatibility barriers
- 1.7 Somaclonal variations and crop improvement
- 1.8 Anther and pollen culture and production of haploids
- 1.9 Technology of freeze preservations and crop improvement

Credit II Production of commercially useful compounds by cell cultures

- 2.1 Advantages of cultured plant cells and tissues as a source of secondary plant products
- 2.2 Cell line selection and commercial production of pharmaceutically important compounds using cell culture techniques
- 2.3 Physical and chemical factors that influence the production of secondary metabolites in vitro
- 2.4 permeabilisation, elicitation and immobilisation of cells for enhanced production of secondary products
- 2.5 Induction of hairy root cultures and their uses
- 2.6 Biotransformations using cell culture methods

Credit III Molecular mechanisms of Abiotic stress tolerance in crop plants

- 3.1 Drought stress tolerance
- 3.2 Flooding stress tolerance or submergence tolerance
- 3.3 Salt stress tolerance
- 3.4 High and low (cold) temperature stress tolerance
- 3.5 Photooxidative (light) stress tolerance
- 3.6 Metal stress tolerance

Credit IV Molecular mechanisms of Biotic stress tolerance in crop plants

- 6.1 Insect resistance
- 6.2 Bacterial resistance
- 6.3 Fungal resistance
- 6.4 Viral resistance
- 6.5 Molecular markers and crop improvement

M.Sc Biotechnology - Elective - BT403d U - Environmental Biotechnology

Credit I: Biomass and Bio-fuels

1.1 Plant biomass (Cellulose, starch, pectin, gum materials), Animal biomass (chitin, milk whey, Slaughter house wastes), Microbial biomass (algal blooms -in fresh and sea waters, Fungal- Mushrooms, yeasts and bacterial fermentation biomass wastes)

1.2 Concepts of single cell proteins, probiotics and their applications

1.3 Biomass feed stocks to fermentations

1.4 Microbial production of fuels: alcohols, hydrogen and methane

1.5 Microbial production of polymers (xanthan gums)

Credit II: Bioremediation and Bio-leaching

1.1 Types and sources of pollution - Inorganic, organic and biotic

1.2 Clinical examples of air, water and land pollutions. Environmental impact of pollution and measurement methods

1.3 Composting of organic wastes, microbial bioremediation of oil spills

1.4 Waste water treatment - sewage treatment and common industrial effluent treatment

1.5 Concepts of bioremediation (in-situ and ex-situ), Bioremediation of toxic metal ions – biosorption and bioaccumulation principles. Concepts of phytoremediation

1.6 Microbial biotransformation of pesticides and xenobiotics

1.7 Microbial leaching of ores – direct and indirect mechanisms

Credit III: Biofertilizers and Biopesticides

1.1 Biofertilizers and their importance in crop productivity

1.2 Algal and fungal (mycorrhizae) biofertilizers

1.3 Bacterial biofertilizers (rhizobial, free living N₂ fixers and phosphate solublizing bacteria), their significance and practice

1.4 Biopesticides : Bacterial (Bt pesticides), fungal (Trichoderma)

1.5 Viral biopesticides – Baculovirus, NPV insecticides

1.6 Production of biofertilizers and biopesticides for large scale application

Credit IV : Genetic Engineering in Environmental Biotechnology

1.1 Genetically engineered microorganisms in environmental health

1.2 Genetically engineered plants and microorganisms in agriculture and productivity

1.3 Genetically engineered bacteria in bioremediation of organic pesticides, insecticides oil spills

1.4 Hazards of genetically engineered microorganisms, plants and animals

1.5 Policies of genetic engineering research

M.Sc Biotechnology - BT451 U - Bioinformatics

Practicals

1. Dot-matrix comparison – understanding sliding window – window size (word size) and stringency
2. Pairwise alignment
3. Multiple sequence alignment
4. Searching DNA databases with FASTA and BLAST
5. Searching protein sequence databases with FASTA and BLAST
6. Making Patterns (prosite syntax) and consensus sequence from multiple sequence alignments
7. Compositional analysis of DNA – GC/AT content - codon usage - codon bias
8. Understanding ORF and gene prediction
9. Protein structure visualization
10. Secondary structure prediction online
11. Understanding the bioinformatics behind human, rice, yeast and E.coli genome projects

Recommended Books:

1. Bioinformatics: Sequence and Genome Analysis by David W. Mount, Cold Spring Harbor Laboratory Press
2. Biological Sequence Analysis : Probabilistic Models of Proteins and Nucleic Acids by Richard Durbin, Sean R. Eddy, Anders Krogh, Graeme Mitchison, Cambridge University Press.
3. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, Second Edition by Andreas D. Baxevanis, B. F. Francis Ouellette, Wiley-Interscience
4. Foundations to bioinformatics – Evolution, similar macromolecular components, constancy of gene number and core proteome in closely related organisms
5. Bioinformatics data – nucleic acid sequence, protein sequence, protein structure, genomic, proteomic and metabolomic information
6. Bioinformatics databases – types, design, file formats, access tools with examples
7. Bioinformatics tools and Resources – free online tools, downloadable free tools, software packages, internet, Bioinformatics books and Journals, Bioinformatics web-portals

M.Sc Biotechnology - BT452 U - Bioprocess Engineering

Practicals

1. Quantitative description of bioprocess by estimating specific growth rate of target organism using kinetic models and determination of yield co-efficient
2. Cell/tissue immobilization, production of biomass and harvesting of biological organism for analysis
3. Development of laboratory scale bioreactors: know how
4. Recovery of product from fermentation broth and optimization of parameters
5. Extraction of protein from a crude bioprocess homogenate using Aqueous Two Phase System (ATPS)
6. Purification and identification of unknown compounds from a mixture of compounds using column chromatography and TLC

M.Sc Biotechnology - Elective - BT453a U - Medical Biotechnology

Practicals

1. Genotyping of candidate genes for diseases by RFLP, Microsatellite and VNTR analysis
2. Screening for known mutations by ARMS PCR/ASO
3. Screening for unknown mutations by SSCP and sequencing
4. Detection for dynamic mutations - Trinucleotide repeat polymorphism
5. Identification of disease gene expression by RT PCR
6. Sequencing of c DNA and cloning in expression vectors
7. Identification of fetal cells in maternal blood for detecting genetic defects
9. Detection of congenital abnormalities by triple test

References:

1. Introduction to Human Molecular Genetics – J.J Pasternak, John Wiley Publishers.
2. Human Molecular Genetics –Tom Strachen and A P Read, Bios Scientific Publishers
3. Human Genetics Molecular Evolution, Mc Conkey,
4. Recombinant DNA Technology , AEH Emery
5. Principles and Practice of Medical Genetics, I, II, III Volumes by AEH Edts. Emery

M.Sc Biotechnology - Elective - BT453b U - Animal Biotechnology

Practicals

1. Immunodiffusion techniques - Radial Immuno diffusion and Double diffusion
2. ELISA technique - Dot blotting, Immuno Blotting
3. Raising of monoclonal antibody by cell culture, PCR based technique
4. Microinjection of DNA sequence
5. Embryonic fixing
6. Developing animal models for diseases like, diabetes, cataract or nutritional deficiency

M.Sc Biotechnology - Elective - BT453c U - Agriculture Biotechnology

Practicals

1. Clonal propagation of elite ornamentals, trees and agricultural plants
2. Introduction of somatic embryos and preparation of synthetic seeds
3. Induction of hairy root cultures for the production of secondary metabolites
4. Permeabilization or immobilization of cells and measurement of secondary plant products
5. Screening of libraries by colony hybridization
6. Confirmation of transgenics by Southern blotting technique and by PCR
7. Genetic transformation of plants using *Agrobacterium tumefaciens*

Books Recommended

1. Plant Tissue Culture and its Biotechnological Applications By W. Barz, E. Reinhard, M.H. Zenk
2. Plant Tissue Culture By Akio Fujiwara
3. Frontiers of Plant Tissue Culture By Trevor A. Thorpe
4. In Vitro Haploid Production of Higher Plants By S. Mohan Jain, S.K. Sopory, R.E. Veilleux
5. Plant Tissue Culture : Theory and Practice By S.S. Bhojwani and A. Razdan
6. Plant Cell, Tissue and Organ Culture Applied AND Fundamental Aspects By Y.P.S. Bajaj and A. Reinhard

M.Sc Biotechnology - Elective - BT453d U - Environmental Biotechnology

Practicals:

1. Biomass estimation by different methods
2. Isolation of Biofertilizer microbes by biological enrichment method
3. Production of microbial biofertilizers and biopesticides
4. Efficacy testing for biofertilizers (nodulation test for rhizobia) and biopesticides
5. Estimation of BOD
6. Testing for microbiological quality of potable water (Coli form test)
7. Microbial degradation of organic matter
8. Testing for effect of chemical pesticides on soil microbial respiration
9. Testing for microbial biodegradation of pesticides
10. Development of genetically engineered microorganisms for bioremediation

Recommended Books

1. Comprehensive Biotechnology (All volumes) Ed. Young, M.Y. Pub: Pergmon Press
2. Environmental Microbiology. Grant, WD and Long PE. Publ: Blakie, Glasgow
3. Biotreatment systems Vol. 22. Ed. Wise, DL.
4. Microbial Ecology: Principles, Methods and Applications by Lavin, Seidler, Rogul
5. Laboratory Experiments in Microbiology by Gopal Reddy et al.