



जननायक चंद्रशेखर विश्वविद्यालय, बलिया
Jananayak Chandrashekhar University, Ballia



2020 onwards

**SYLLABUS STRUCTURE SEMESTER WISE
M.Sc. (BIOTECHNOLOGY)**

M.Sc. (BIOTECHNOLOGY) PREVIOUS YEAR

FIRST SEMESTER

400 MARKS

PAPER	DESCRIPTION		MARKS
PAPER I(MBT-101)	CELL BIOLOGY		75
PAPER II(MBT-102)	GENETICS & MOLECULAR BIOLOGY		75
PAPER III(MBT-103)	BIOCHEMISTRY		75
PAPER IV(MBT-104)	BIOPHYSICS		75
PRACTICAL	BASED ON PAPER 101-104	-	100
	TOTAL	-	400

SECOND SEMESTER

400 MARKS

PAPER	DESCRIPTION		MARKS
PAPER I(MBT-201)	GENERAL MICROBIOLOGY		75
PAPER II(MBT-202)	RECOMBINANT DNA TECHNOLOGY		75
PAPER III(MBT-203)	IMMUNOLOGY & IMMUNOTECHNOLOGY		75
PAPER IV(MBT-204)	BIostatISTICS & BIOINFORMATICS		75
PRACTICAL	BASED ON PAPER 201-204		100
	TOTAL	-	400

M.Sc. (BIOTECHNOLOGY) FINAL YEAR

THIRD SEMESTER

400 MARKS

PAPER	DESCRIPTION		MARKS
PAPER I(MBT-301)	INDUSTRIAL MICROBIOLOGY		75
PAPER II(MBT-302)	CELL & TISSUE CULTURE		75
PAPER III(MBT-303)	APPLIED MOLECULAR BIOLOGY		75
PAPER IV(MBT-304)	ENVIRONMENTAL BIOTECHNOLOGY		75
PRACTICAL	BASED ON PAPER 301-304	-	100
	TOTAL	-	400

FOURTH SEMESTER

400 MARKS

PAPER	DESCRIPTION		MARKS
PAPER I(MBT-401)	BIOCHEMICAL ENGINEERING		75
PAPER II(MBT-402)	ETHICS, PATENTING AND BIO-ENTREPRENEURSHIP		75
PAPER III(MBT-403)	MEDICAL GENETICS		75
PRACTICAL (BASED ON PAPER MBT-401-403)	PROJECT WORK- PRESENTATION + VIVA VOCE (100+75)		175
	TOTAL	-	400
	GRANT TOTAL-ALL SEMESTERS	-	1600

Note: There will be 9 questions in each paper and candidate has to attempt only 5 questions. **Q.1** will carry short answers and will be **compulsory** based on units I - IV. **Two** questions will be set from **each unit**, out of which one question has to be attempted. Candidate must obtain minimum pass marks in Theory and Practical Examinations separately.

**M.Sc. (Biotechnology) Practical
Marks Distribution
(w.e.f. 2020- 2021)**

M.Sc Ist Semester	100 Marks
Paper I	15
Paper II	15
Paper III	15
Paper IV	15
Class Record, chart/ model	10
Spot (5) 5×2	10
Viva	10
Seminar	10
M.Sc IInd Semester	100 Marks
Paper I	15
Paper II	15
Paper III	15
Paper IV	15
Class Record, chart/ model	10
Spot (5) 5×2	10
Viva	10
Seminar	10
M.Sc IIIrd Semester	100 Marks
Paper I	15
Paper II	15
Paper III	15
Paper IV	15
Class Record, chart/ model	10
Spot (5) 5×2	10
Viva	10
Seminar	10
M.Sc IVth Semester	175 Marks
Project presentation/ dissertation	100
Power point Presentation with Viva voce	75

M.Sc. (BIOTECHNOLOGY) PREVIOUS YEAR FIRST SEMESTER

PAPER I: CELL BIOLOGY

MM. 75

UNIT I

1. Cell Structure and function: Cell theory, organization of eukaryotic cell and plant cell wall
2. A brief account of structure and function of plasma membrane
3. Golgi complex, Glycosylation and cell secretion
4. Endoplasmic reticulum and protein segregation

UNIT II

5. Mitochondria structure and its functions
6. Chloroplast
7. Centrosome and spindle apparatus
8. Lysosomes, peroxisomes, glyoxisomes and their role in cell metabolism

UNIT III

9. Nucleus: Nuclear envelope, chromatin and chromosomes organization, euchromatin and heterochromatin, metaphase chromosome, genes and chromosomes, C-value paradox, centromere, telomere, karyotype and chromosome banding, *in-situ* hybridization and chromosome painting
10. Structural and numerical changes in chromosomes with special emphasis on translocation, deletions in tumors, syndromes and ploidy in plants.

UNIT III

11. Cell interaction and cell-cell adhesion
12. Cytoskeleton: microfilaments, microtubules and intermediate filaments

Books Recommended:

1. Powar, C.B. (2010). Cell Biology. Himalaya publishing house, Mumbai.
2. Karp, G. (2013). Cell Biology, Wiley.
3. Verma, P.S. & Agarwal, V.K. (2016). Cell biology. S. Chand & Company Ltd., New Delhi.
4. Rastogi, S.C. (2005). Cell Biology. New age Publishers, New Delhi.
5. Sheeler, P. & Bianchi, D.E. (2009). Cell and Molecular Biology. Wiley.
6. Gupta, P.K. (2014). Cell and Molecular Biology. Rastogi Publications, Meerut.
7. De Robertis, E.D.P. & De Robertis, Jr. E.M.F. (1987). Cell and Molecular biology. Lea and Febiger, U. S.
8. Lodish, H., Baltimore, D., Berk, A., Zipursky, S.L., Matsudaira, P. and Darnell, J.(1999).Molecular Cell Biology, WH Freeman, USA
9. Bruce, A., Bray, D., Hopkin, K., Johnson, A., Lewis, J., Raff ,M., Roberts, K. and Walter, P.(1990). Essential Cell Biology, Garland, USA
10. Alberts, B., Johnson ,A., Lewis, J., Raff, M., Roberts, K. and Walter, P.(1998).Molecular Biology of the Cell, Garland, USA
11. Stryer, L., Berg, J. and Tymoczko, J. (2001).Biochemistry, W.H.Freeman,USA
12. David,L.N.,and Michael,M.C.(204).Lehinger:Principles of Biochemistry,W.H.Freeman,USA
13. Karp,G.(2003).Karp:Cell and Molecular Biology:Concepts and Experiments,Wiley (Asia Pvt.,Ltd).

PAPER II: GENETICS AND MOLECULAR BIOLOGY MM. 75

UNIT I

1. Recapitulation of Mendel's Laws of Inheritance and gene interaction.
2. Linkage, crossing over (molecular mechanisms of genetic recombination in pro- and eukaryotes) and gene mapping.
3. Transposable elements.

UNIT II

4. Genetic code: deciphering genetic code, degeneracy, unusual codons in mitochondria and prokaryotes.
5. Mutations: types, mechanisms, mapping, mutagens, Ames test for mutagens
6. Replication of genetic material in prokaryotes and eukaryotes, a brief description of initiation at replication origins and its cell cycle regulation

UNIT III

7. DNA damage and repair, types of damage and their repair (repair by proofreading, mismatch repair(Mut HLS system of *E.coli*),Excision repair(UvrABC mechanism of *E.coli*),repair of double strand breaks, photo reactivation, SOS repair
8. Gene organization in prokaryotes and eukaryotes, polycistronic genes, split genes promoters, enhancers.
9. Mechanism of transcription in prokaryotes and eukaryotes: transcription factors, RNA polymerases, initiation, elongation and termination.
10. RNA processing: processing of mRNA, tRNA and rRNA.

UNIT I

11. Translation.
12. Regulation of gene expression: Prokaryotes- lac and trp operons in *E.coli*. An overview of regulation of gene expression in eukaryotes.
13. Signaling: an introduction to signaling, different type of ligands, receptors, G-proteins, second messengers, Ras and RTK signaling.
14. Cell cycle and its regulation: role of growth factors, cyclins, Cdks with yeasts and higher eukaryotic cells as examples.

Books Recommended:

1. Strickberger, M.W. (2015). Genetics. Pearson Education, India.
2. Gardner, E.J., Simmons, M.J. & Snustad, D.P. (2006). Principles of Genetics. Wiley.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. & Palladino, M.A. (2016). Concepts of Genetics. Pearson Education, India.
4. Singh, B.D. (2009). Genetics. Kalyani Publishers, New Delhi.
5. Gupta, P.K. (2009). Genetics. Rastogi Publishers, Meerut.
6. Gupta, P.K. (2007). Cytogenetics. Rastogi Publishers, Meerut.
7. Prasad, G. (2013). Introduction to Cytogenetics. Kalyani Publisher, New Delhi.
8. Roy, D. (2009). Cytogenetics. Narosa Publishing House, New Delhi.
9. James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Losick, *Molecular Biology of Genes*, The Benjamin/ Cummings Publishing Company, New York
10. T. A. Brown, *Genomes*, Wiley Publishers (Asia Pvt Ltd).
11. Lubert Stryer, Jeremy Berg, John Tymoczko *Biochemistry*, W.H.Freeman, USA
12. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter, *Molecular Biology of the Cell*, Garland, USA.
13. David L. Nelson, Michael M. Cox, *Lehninger: Principles of Biochemistry*, W.H.Freeman, USA.
14. Hartl and Jones, *Genetics*, Jones and Bartlett publishers, USA.
15. H.K.Das, *Textbook of Biotechnology*, Wiley Dreamtech India Pvt. Ltd.
16. Voet and Voet, *Biochemistry*, John Wiley and sons (Asia Pvt Ltd).
17. Benjamin Lewin, *Gene VIII*, Oxford University press, U.K.

PAPER III: BIOCHEMISTRY

MM. 75

UNIT I

1. Introduction to biochemistry and biomolecules.
2. Chemical foundations of biology- pH, pK, acids, bases and buffers.
3. Metabolism of Carbohydrates- Gluconeogenesis, Glycolysis and Feeder pathways, secondary pathway of glucose oxidation-PPP & glucuronic acid pathway & TCA, Glyoxylate cycle.

UNIT II

4. Metabolism of Fatty acids- β -oxidation of saturated and unsaturated (mono & poly), odd & even chain fatty acids.
5. Oxidation of amino acids and urea cycle.
6. Introduction to biosynthesis of amino acids, purines and pyrimidines.

UNIT III

7. Introduction to vitamins, hormones, phytohormones and their role.
8. Introduction to secondary metabolic products- alkaloids, terpenoids, flavonoids, steroids and pigments.
9. Photosynthesis- (C_3 cycle, C_4 cycle), Oxidative phosphorylation and Photophosphorylation and photorespiration (C_2 cycle).

UNIT IV

10. Classification, nomenclature and general properties of enzymes; kinetics of enzyme actions, rate of enzyme catalyzed reactions with special reference to Michaelis Menten laws; units of enzyme activity, factors affecting enzyme activity (substrate concentration, temperature, pH and inhibitors). A brief description of various types of coenzymes, isozymes and zymogens. Enzyme inhibition- competitive, noncompetitive and uncompetitive types. Brief introduction to active site.
11. Amino acids, peptide classification and their general chemical properties, peptide sequencing.

Books Recommended

1. Goodwin, T.W. & Mercer, E.I. (2003). Introduction to Plant biochemistry. CBS Publishers & Distributors Pvt. Ltd., New Delhi.
2. Day, P.M. & Harborne, J.B. (1997). Plant Biochemistry. Academic Press, UK.
3. Christopher K. Mathews, K.E. van Holde and Kevin G. Ahern, *Biochemistry*, Pearson Education (Singapore) Pte. Ltd. Indian Branch, 482 F.I.E. Patparganj, Delhi..
4. Conn, E.E., Stumpf, P.K., Bruening, G. & Doi, R.H. (2006). Outlines of Biochemistry. Wiley.
5. Lehninger, A.L. (2013). Biochemistry. Kalyani publishers, New Delhi.
6. Jain, J.L., Jain, S. & Jain, N. (2016). Fundamentals of Biochemistry. S. Chand & Company Ltd., New Delhi.
7. Lubert Stryer, *Biochemistry*, W.H. Freeman and Company, New York.
8. D.L. Nelson, M.M. Cox, *Lehninger's Principles of Biochemistry*, Macmillan Worth Pub. Inc. New York
9. Geoffery Zubey, Biochemistry, Macmillon Publishing Company, New York
10. Donald Voet and Judith Voet, *Biochemistry*, John Wiley & Sons, New York

PAPER IV: BIOPHYSICS

MM. 75

UNIT I

1. **Chemical interactions**- characteristics of chemical bonds, Types and importance of weak and strong chemical interactions, Intra and inter molecular interactions.
2. **Carbohydrates**- Structure of carbohydrates; Monosaccharides- classification, optical activity, mutarotation and isomerism; Disaccharides, Polysaccharides- Homopolymers and Heteropolymers, Glycoproteins.
3. **Nucleic Acids**- Nucleic acid composition, Glycosidic bond rotation, Sugar ring conformation, backbone torsional angles and forces stabilizing ordered secondary structures. Topology of DNA, A, B and Z types of DNA, DNA melting curves and hypochromicity, tRNA, micro-RNA.

UNIT II

4. **Proteins**- Amino acids: General properties, classification and characteristics, peptide bonds, disulfide cross links, conformational properties of dipeptides. Ramachandran Plots & its use to predict sterically permissible structures. Hierarchies of protein structure-primary, secondary structures (helix and sheet), Domains, Motifs and folds. Forces stabilizing molecular structure, tertiary structure and quaternary structure. Fibrous and Globular proteins.
5. **Lipids**- Classification, structure and function.
6. **Biological transport**- Theory and thermodynamics of biological transport, principles of biological transport, different types of transports across membrane, simple diffusion, facilitated diffusion, primary and secondary active transport and group translocation.

UNIT III

7. **Techniques**-
 - a. Microscopic techniques: A brief description of Light, Phase Contrast, Fluorescence microscopy techniques and their application in cell biology. Basics of Confocal microscopy, Transmission and Scanning electron Microscopy.
 - b. Other techniques: Fluorescence activated cell sorting, Autoradiography, Centrifugation, Biosensors, Electrophoresis of proteins and nucleic acids.

UNIT IV

8. **Biophysical methods**: Analysis of biomolecules, use of UV/VIS Spectrophotometry, Fluorescence, Circular Dichroism, NMR and ESR Spectroscopy.
9. **Nanobiotechnology**: Nanoparticles, biomedical application of nanotechnology.

Books Recommended

1. Goodwin, T.W. & Mercer, E.I. (2003). Introduction to Plant biochemistry. CBS Publishers & Distributors Pvt. Ltd., New Delhi.
2. Day, P.M. & Harborne, J.B. (1997). Plant Biochemistry. Academic Press, UK.
3. Wilson, K. & Walker, J. (2013). Principles and Techniques of Biochemistry and Molecular biology. Cambridge University Press, London.
4. Conn, E.E., Stumpf, P.K., Bruening, G. & Doi, R.H. (2006). Outlines of Biochemistry. Wiley.
5. Lehninger, A.L. (2013). Biochemistry. Kalyani publishers, New Delhi.
6. Berg, J.M., Tymoczko, J.L. & Stryer, L. (2002). Biochemistry. W.H.Freeman & Co. Ltd.
7. Banarjee, P.K. (2010). Introduction to Biophysics. S.Chand & Co.Ltd., New Delhi.
8. Narayanan, P. (2007). Essentials of Biophysics. New Age International Pub. New Delhi.

M. Sc. (Biotechnology) Semester-I Practical

PAPER I- CELL BIOLOGY

1. Karyotype preparation and Idiogram
2. Mitotic metaphase chromosome preparation from bone marrow of rat/mouse.
3. Fluorescence banding of mitotic chromosomes of mouse/rat
4. Demonstration of septum in fission Yeast by calcoflour (Tinopal).
5. Vital staining of Mitochondria with Janus green B.
6. Demonstration of diversity of cell types (Muscle and Neuron).
7. Determination of Sex chromatin in buccal smear.
8. Study of Mitosis (squash method using root tip of onion) and Meiosis (Smear preparation using pollen grains).
9. Model / Photo Study of Cell Organelles (Spotting)

PAPER II: GENETICS AND MOLECULAR BIOLOGY

1. Genetics problems based on Mendel's Laws.
2. Genetics problems based on Exception to Mendel's Laws.
3. Genetics problems based on Interactions of Genes.
4. Genetics problems based on Gene Mapping.
5. Genetics problems based on Transposable elements.
6. C-banding of mitotic chromosome of mouse/rat.
7. G-banding of mitotic chromosome of mouse/rat.
8. Ames test for mutagenesis.
9. Genetic experiment- Drosophila model.

PAPER III: BIOCHEMISTRY

1. Determination of pK_a value of weak acids by titrating with strong base.
2. Estimation of DNA by Diphenylamine method.
3. Estimation of RNA by Orcinol method.
4. Estimation of reducing and total sugar by DNS and H_2SO_4 -phenol method.
5. Determination of R_f values of amino acids by TLC/PC using Ninhydrin.
6. Enzyme production and its activity measurement.
7. Effect of pH and temperature on enzyme activity.
8. Titration of Ascorbic acids using 2, 6 dichloropheno-endophenol dye.
9. Determination of acid value of fats.

PAPER IV: BIOPHYSICS

1. Basic principles, components and handling of Microscopes (Dissecting, Compound).
2. Basic principles, components and handling of Centrifuges (Bench, High-speed & Ultra).
3. Basic principles, components and handling of Colorimeter/spectrophotometer.
4. Basic principles, components and handling of Electrophoretic apparatus.
5. Quantitative estimation of proteins using UV-Vis spectrophotometer by method of Lowry et al.
6. Estimation of proteins using UV-Vis spectrophotometer by Biuret method.
7. Estimation of DNA using UV spectrophotometer.
8. Separation of red blood cell proteins by Electrophoresis.
9. Separation of DNA by Electrophoresis.

M.Sc. (BIOTECHNOLOGY) PREVIOUS YEAR SECOND SEMESTER

PAPER I: GENERAL MICROBIOLOGY

MM. 75

UNIT I

1. Introduction, history, scope and relation with other sciences.
2. Structure and functions of prokaryotic cells and their components- cell wall, cell membrane, capsule, pilli, mesosomes, nucleoid, flagella, etc.
3. Types of Microorganisms- General structure and classification.

UNIT II

4. Introduction to Archea- extremophiles.
5. Introduction to growth, reproduction and nutrition in bacteria. Factors affecting growth.
6. Media preparation and sterilization methods.

UNIT III

7. Isolation and cultivation of bacteria and fungi.
8. Bacterial viruses- types and multiplication.
9. Introduction to microbial metabolism and specialized pathway.

UNIT I

10. Brief account of transformation, transduction and conjugation in bacteria.
11. Microorganism in relation to plants, animals and human beings.
12. Role of microorganisms in elemental recycling.

Books Recommended

1. Pelczar, M.L., Reid, R.D. & Chan, E.C.S.(2009). Microbiology. Tata McGraw-Hill, New Delhi.
2. Presscott, L.M., Harley, J.P. & Klein, D.A.(2010).Microbiology.McGraw-Hill,New York.
3. Singh, R.P. (2017). Microbiology. Kalyani Publishers, New Delhi
4. Sharma, P.D. (2016). Microbiology. Rastogi Publishers, Meerut, U.P.
5. Mandahar, C.L. (1978).Introduction to Plant Viruses.S.Chand & Co.Ltd., New Delhi.
6. Baveja, C.P. (2017).Text Book of Microbiology.Arya Publications, New Delhi.
7. Maheshwari, D.K. & Dubey, R.C. (2013).A Text Book of Microbiology. S.Chand & Co. N.Delhi.
8. Tortora, G.J., Funke, B.R. & Case, C.L. (2016).Microbiology-An Introduction. Pearson Education India, New Delhi.
9. Sastry, A.S. & Bhat, K.S. (2018).Essentials of Practical Microbiology. Jaypee Brothers Medical Publishers, New Delhi.
10. Mahapatra, P.K. (2008).Textbook of Environmental Microbiology. IK International Publishing House Pvt.Ltd, New Delhi.
11. Presscott, Harley, Klein, *Microbiology-*, WCB Mc Graw Hill, New York
12. Madigan, Martinko, Parker , *Brock's Biology of Microorganisms* ,
Prentice Hall, New Delhi.
13. J Black , *Microbiology: Principles and Explorations* , John Wiley & Sons, New York.
14. Cappuccino Sherman , *Microbiology- A Laboratory manual*, Benjamin Cummings.
15. R Y Stanier et al , General Microbiology, Mc Millan Press Ltd., New Delh
16. Pelczar et al , *Microbiology* , Tata Mac Graw Hill , New Delh

PAPER II: RECOMBINATION DNA TECHNOLOGY MM. 75

UNIT I

1. Vectors: Host system, cloning vectors (Plasmids, Phages, Cosmids, Bacterial Artificial Chromosomes and Yeast Artificial Chromosomes, Shuttle Vectors, Expression Vectors)
2. Enzymes used for manipulating DNA (Restriction endonucleases, methylases, polymerases, ligases, kinases and nucleases).
3. Ligation, preparation of component cells and their transformation.

UNIT II

4. Isolation of DNA (Plasmid, Phage, Cosmid and Genomic DNA) and RNA from prokaryotes and eukaryotes using Electrophoresis.
5. Construction of Genomic and c DNA libraries.
6. Screening and characterization of cloned DNA, Restriction mapping and RFLP analysis.

UNIT III

7. Southern, Northern and Western Blotting, probe preparation and hybridization.
8. PCR and its application.
9. DNA sequencing
10. Site directed mutagenesis.

UNIT IV

11. DNA-Protein interaction: Gel Shift Assay, Foot-printing.
12. Protein-protein interaction: Immunoprecipitations, Yeast Two Hybrid System.
13. Modulation of gene expression- RNAi, Antisense RNA.

Books Recommended

1. Govil, C.M., Aggarwal, A. & Sharma, J. (2017). Plant Biotechnology and Genetic Engineering. PHI Learning Pvt Ltd, Delhi.
2. Bhojwani, S.S. & Razdan, M.K. (1996). Plant tissue Culture: Theory and Practice. Elsevier Science Publisher, New York.
3. Slater, a., Scott, N. & Fowler, M. (2010). Plant biotechnology: The Genetic manipulation of Plants. Oxford University Press, oxford.
4. Dube, R.C. (2014). A Text Book of Biotechnology. S. Chand & Company Ltd., New Delhi
5. Singh, B.D. (2012). Biotechnology. Kalyani Publishers, New Delhi.
6. Gupta, P.K. (2016). Plant Biotechnology. Rastogi Publications, Meerut.
7. Chawla, H.S. (2006). Introduction to Plant Biotechnology. Oxford & IBH Publishing Co. Pvt. Ltd., N.Delhi.
8. Kumaresan, V. & Arumugam, N. (2016). Fundamentals of Biotechnology. Saras Publication, Kanyakumari.
9. Janarthanan, S. & Vincent, S. (2009). Practical Biotechnology. Universities Press, Hyderabad.
10. S.B Primerose, R M Twyman, *Principles of Gene Manipulation and Genomics*, Blackwell Science (Asia Pvt Ltd).
11. Richard J. Reece, *Analysis of gene and genome*, John Wiley and sons (Asia Pvt Ltd).
12. H.K. Das, *Textbook of Biotechnology*, Wiley Dreamtech India Pvt. Ltd.
13. T.A. Brown, *Principles of Gene Manipulation and Genomics*, Wiley Blackwell Publishers (Asia Pvt Ltd)
14. Bernard R. R. Glick, Jack J. Pasternak, Jack J. Pasternak, Jack J. Pasternak, *Molecular Biotechnology: Principles and Applications of recombinant DNA*, ASM Press, U.S.A.
15. J Sambrook & EF Fritsch, *Molecular Cloning: A laboratory manual*, Cold Spring Harbor Laboratory press, U.S.A.

PAPER III: IMMUNOLOGY AND IMMUNOTECHNOLOGY MM. 75

UNIT I

1. Basic concepts of Immunology: (a) Innate and acquired immunity. (b) Concept of Humoral & Cell Mediated Immunity.
2. Organization and structure of Lymphoid organs.
3. Cells of the Immune system: B-Lymphocytes, T- Lymphocytes, Macrophages, Dendritic cells, N K Cells, Eosinophils, Basophils, Neutrophils, Mast cells.
4. Nature and Biology of antigen, superantigen.

UNIT II

5. Immunoglobins: Structure, Types and Functions.
6. Generation of Antibody Diversity, BCR, TCR.
7. Antibody-Antigen Interaction: Precipitation Reactions, Agglutination reactions, Radio Immunoassay and ELISA.
8. Major Histocompatibility Complex.

UNIT III

9. Antigen processing and presentation.
10. Generation of Humoral and cell Mediated immune response.
11. Cell Mediated Cytotoxicity: Mechanism of T-cells and N K cell mediated lysis. ADCC, macrophage mediated cytotoxicity.
12. Complement System Components, activation, regulation and biological consequences.

UNIT IV

13. Hypersensitivity- (2) - Classification, mediators, regulation, detection and therapy.
14. Transplantation immunology.
15. AIDS
16. Immunization (Active & Passive) and Vaccines (Types and Importance).
17. Hybridoma Technology and Monoclonal Antibodies.

Books Recommended

1. Chakravarty, A.K. (2006). Immunology and Immunotechnology. Oxford University press. New Delhi.
2. Annadurai, B. (2010). A Textbook of Immunology and Immunotechnology. S. Chand & Co. Ltd. , New Delhi.
3. Paul, A. (2016). Textbook of Immunology: Including Immunotechnology and Immunotherapy. Books & Allied (P) Ltd., Kolkata.
4. Pandian, M.R. & Kumar, B.S.(2007). Immunology and Immunotechnology. Panima Publishes, New Delhi.
5. Moran, A. (2001). Immunotechnology- Principles, concepts and applications. Wiley-Blackwell, NY
6. Ramesh, S.R. (2017). Immunology. McGraw Hill Education India Pvt. Ltd., New Delhi.
7. Fatima, D. & Arumugam, N. (2014). Immunology. Saras publication, Kanyakumari, TN.
8. Basir, S.F. (2012). Textbook of Immunology. PHI Learning Pvt. Ltd., New Delhi.
9. Madhavee, L.P. (2012). A Textbook of Immunology. S. Chand & Co. Ltd. , New Delhi.
10. Richard A Goldsby, Thomas J Kindt, Barbara S Osborne : Kuby's Immunology. 5th Edition , W.H.Freeman & Coy , New York
11. Abbas , Basic Immunology: Functions& disorders of the immune system , WB Sanders Co. Philadelphia.
12. William Paul : Fundamental Immunology , Lippincot Raven, Philadelphia
13. Roitt : Essential Immunology :9th Edition, Blackwell Science ltd. Londo
14. DP Stites, AL Terr, TG Parslow : Medical Immunology, 10th Edition, Appleton and Lange , New York
15. David Male, Jonathan Brostoff, David Roth & Ivan Roitt: Immunology: 7th Edition: Mosbey Title: Philadelphia
16. EP Diamandis and Theodore K Christopoulos: Immunoassay , Academic press, Sandiego, USA
17. Ronald W Ellis : Vaccines- new approaches to immunological problems , Butterworth Henimann, Boston, USA
18. Hay, Frank C: Practical immunology: Blackwell ScienceLtd. London

BIOSTATISTICS**UNIT I:**

1. Scope of biostatistics, Variables in biology.
2. Collection, classification, tabulation, diagrammatic and graphic presentation of data.
3. Concepts of statistical population and sample.
4. Measures of Central Tendencies and Dispersion.
5. Simple measure of Skewness and kurtosis.

UNIT II

6. Probability: Definition, Simple theorems and simple applications of probability.
7. Correlation, correlation coefficient, standard error of estimate and regression, linear regression, least square method of fitting.
8. Basic idea of significance, testing level of significance, random variations
9. Chi-square (χ^2) test, ANOVA

BIOINFORMATICS**UNIT III**

10. Introduction, classification and generation of Computers, components of a computer system, input and output devices
11. Biological Data Base: Primary, Secondary and Composite data base
12. Nucleotide sequence data base
13. Protein sequence data base

UNIT III

14. Structural sequence data base
15. Sequence analysis; Sequence alignment; types and methods.
16. Primer designing
17. Role of Bioinformatics in drug discovery and development

Books Recommended

1. Banerjee, P.K. (2007). Introduction to Biostatistics. Rastogi publication, Meerut.
2. Rastogi, V.B. (2015). Biostatistics. Meditech Publishers, New Delhi.
3. Ramakrishna, P. (2015). Biostatistics. Saras Publication, Kanyakumari, TN.
4. Prasad, S. (2009). Elements of Biostatistics. Rastogi Publication, Meerut.
5. Ambrosius, W.T. (2010). Topics in Biostatistics. Humana Press. New Jersey.
6. Ghosh, Z. & Mallick, B. (2008). Bioinformatics: Principles and Application. Oxford Higher Education, India.
7. Attwood, T. (2007). Introduction to Bioinformatics. Pearson, India., New Delhi.
8. Rastogi, S.C., Mendiratta, N. & Rastogi, P. (2009). Bioinformatics: Concepts, Skills and Applications. CBS Publishers & Distributors, New Delhi.

M. Sc. (Biotechnology) Semester-II Practical

PAPER I- GENERAL MICROBIOLOGY

1. Instruments and equipments commonly used in microbiology.
2. Washing and Sterilization techniques of Lab Wares.
3. Different Media preparations for growing (i) Bacteria (ii) Moulds (iii) Yeast.
4. Culturing of Microorganisms (i) Slant Preparation (ii) Suspension culture (iii) Streaking (iv) Plating.
5. Simple and Gram staining technique.
6. Isolation of soil microbes by plate streaking method.
7. Counting of microorganisms using Haemocytometer in a given sample using Serial dilution.
8. Size measurement of microorganisms using stage and ocular micrometer.
9. Growth measurement by optical density/plating method.

PAPER II: RECOMBINATION DNA TECHNOLOGY

1. Preparation of bacterial growth medium (L.B., 2XYT)
2. Preparation of component bacterial cell.
3. Transformation of E.coli cells (colour selection of transformants- with/without inserts) X-gal and IPTG.
4. Mini plasmid DNA preparation (this DNA can be digested and relegated).
5. Concentration estimation by Agarose Gel Electrophoresis.
6. Restriction digestion.
7. Ligation.
8. Southern blotting.
9. Probe preparation/hybridization (non-radioactive)

PAPER III: IMMUNOLOGY AND IMMUNOTECHNOLOGY

1. Blood film preparation and identification of cells.
2. ABO blood grouping
3. Immunization (proposed).
4. Antigen-antibody reaction, precipitation (proposed).
5. ELISA (proposed).
6. Immunoelectrophoresis (proposed).

PAPER IV: BIostatISTICS AND BIOINFORMATICS

1. Numerical problems to calculate central tendencies (Mean, Median & Mode).
2. Numerical problems to calculate dispersion-Mean Deviation & Standard Deviation
3. Measures of scewness and kurtosis.
4. Numerical problems to calculate Chi square value (Goodness of Fit, Contingency table)
5. Probability problems
6. Binomial and poisson distribution.
7. Correlation and regression analysis.
8. Computers arithmetic.
9. Practical application of DOS, Windows, Excel and Word.

M.Sc. (BIOTECHNOLOGY) FINAL YEAR

THIRD SEMESTER

PAPER I: INDUSTRIAL MICROBIOLOGY

MM. 75

UNIT I

1. Introduction, history, scope and relation with other sciences.
2. Screening for new metabolites: Primary and secondary products.
3. Strain development through selection, mutations and recombination, and other recent genetic/biochemical methods.
4. Substrates for fermentation: Nature, types and availability.

UNIT II

5. Fermentation: different types and systems for optimization of productivity.
6. Design and working of typical bioreactor.
7. Bioreactor for immobilized cells/enzyme system.
8. Scale up, automation and use of computers in fermentation.

UNIT III

9. Downstream process for product recovery: isolation, purification and concentration through physical/ chemical means.
10. Production of Alcohols (Ethanol), Organic acids, (Citric acid), Amino acids (Lysine & Glutamic acid), Solvents (Glycerol, Acetone & Butanol), Nucleotides.
11. Production of Biologically active compounds: Antibiotics (Penicillin), Vitamins (B-12, Riboflavin), enzymes (Amylase, Protease).

UNIT IV

12. Steroid transformation
13. Production of microbial food and Single Cell Protein.
14. Mushroom: production, nutritive and medicinal value.
15. Microorganisms as Biofertilizers and Biopesticides.

Books Recommended

1. Sastry, A.S. & Bhat, K.S.(2018).Essentials of Practical Microbiology. Jaypee Brothers Medical Publishers, New Delhi.
2. Mahapatra, P.K. (2008).Textbook of Environmental Microbiology. IK International Publishing House Pvt. Ltd., New Delhi
3. Ahmed, N., Qureshi, F.M. & Khan, O.Y. (2001). Industrial and Environmental Biotechnology. Garland Science, New Delhi.
4. Pramanik, K. & Patra, K.K. (2014). Industrial and Environmental Biotechnology. Studium Press India Pvt Ltd.
5. Singh, R.P. (2017). Microbiology. Kalyani Publishers, New Delhi.
6. Sharma, P.D.(2016). Microbiology. Rastogi Publishers, Meerut, U.P.
7. Maheshwari,D.K, D.K, D.K. & Dubey, R.C. (2013).A Text Book of Microbiology. S.Chand & Co. New Delhi.
8. Stanbury, P.F & Whittacker , *Principles of Fermentation technology* , Pergamon.Press Oxford
9. Michael L Shuler & Fikret Kargi , *Bioprocess Engg.: Basic concepts* , Prentice Hall, New Delhi.
10. M.Yoong (Ed-in-Chief) , *Comprehensive Biotechnology Vol 3* , Pergamon, Oxford
11. B.D.Singh , *Biotechnology- Expanding Horizons* , Kalyani Publishers ,NewDelhi
12. H.K.Das , *Text book of Biotechnology* , Wiley Publications , New Delhi

PAPER II: CELL AND TISSUE CULTURE

MM. 75

Plant Cell and Tissue culture

UNIT I

1. Laboratory requirements and basic aseptic techniques
2. Culture media: composition and preparation
3. Cell Culture: Initiation and maintenance of callus and suspension cultures
4. Organogenesis, somatic embryogenesis, factors affecting somatic embryogenesis, artificial seeds

UNIT II

5. Protoplast isolation, culture and fusion, selection of hybrid cells.
6. Somaclonal and gametoclonal variations.
7. Clonal propagation/Micropropagation.
8. Cryopreservation and germplasm conservation
9. Introduction to intellectual property and IPR, importance of IPR.

ANIMAL CELL AND TISSUE CULTURE

UNIT III

10. Equipments and materials animal cell culture technology.
11. Physiochemical properties of media, balanced salt solution, complete media and serum.
12. Serum free media.
13. Biology and characterization of cultured cells.
14. Basic technique of mammalian cell culture in vitro; disaggregation of the tissue, primary culture, cell separation.

UNIT IV

15. Cell lines(finite and continuous) selection and routine maintenance
16. Cell cloning, selection and quantitation.
17. Measurement of viability and cytotoxicity.
18. Biosafety issue in biotechnology, safety protocols.
19. Introduction to Bioethics.

Books Recommended

1. Bhojwani, S.S. & Razdan, M.K. (1996). Plant tissue Culture: Theory and Practice. Elsevier Science Publisher, New York.
2. De, K.K. (2008). Plant Tissue Culture. New Central Book Agency, Allahabad.
3. Razdan, M.K. (2005). Introduction to Plant Tissue Culture. Oxford & IBH Pub., New Delhi.
4. Narayanaswamy, S. (1992). Plant Cell and Tissue Culture. McGraw Hill Education, New Delhi.
5. Pullaiah, E., Subba Rao, M.V. & Sreedevi, E. (2017). Plant tissue Culture: Theory & Practicals. Scientific Pub., Jodhpur.
6. Aruni, A.W. & Ramadass, P. (2011). Animal Tissue Culture. www.mjppublishers. Com
7. Mathur, S. (2006). Animal Cell and Tissue culture. Agrobios (India), Jodhpur.
8. Sambrani, S.A. (2015). Plant and Animal Tissue Culture. Vision Pub., New Delhi.
9. Masters, J.R.W. (2000). Animal Cell Culture: A Practical approach. Oxford University Press, London.

UNIT I

1. Genome Analysis: strategies of human genome project, organization of human genome and comparison with genomes of other organisms (*Drosophila* and Yeast).
2. Embryonic stem cells, neural and hematopoietic stem cells.

UNIT II

3. Gene therapy: current status, problems and future prospects.
4. Gene delivery methods for animals: Viral vectors and vectorless or direct DNA Transfer, Particle bombardment, electroporation, microinjection and chemical methods, creation of animal models for human diseases.

UNIT III

5. DNA fingerprinting: applications and limitations, forensic applications
6. Transgenesis: Methodologies in plants, recent plant transformation technologies, basis of tumor formation, hairy root features of Ti and Ri plasmids, mechanism of DNA transfer, role of virulence genes, use of Ti and Ri plasmids as vectors, binary vectors.

UNIT IV

7. Application of plant transformation for productivity and performance: herbicide resistance, phosphinothricin, glyphosate, sulphonyl urea, atrazine, insect resistance, Bt genes, non-Bt like protease inhibitors, virus resistance, coat protein mediated disease resistance, long self life of fruits and flowers.
8. DNA vaccines, micro arrays, proteomics, pharmacogenomics.

Books Recommended

1. Sheeler, P. & Bianchi, D.E. (2009). Cell and Molecular Biology. Wiley Eastern, New Delhi.
2. Rastogi, S.C. (2010). Molecular Biology of the Cell. New Age International publisher, New Delhi.
3. Gupta, P.K. (2014). Cell and Molecular Biology. Rastogi Publications, Meerut.
4. Gupta, P.K. (2005). Molecular Biology and Genetic engineering. Rastogi Publications, Meerut.
5. Vidyavathi, N. & Chetan, D.M. (2009). Molecular biology. I.K.International Publishing House Pvt. Ltd., New Delhi.
6. De Robertis, E.D.P. & De Robertis, Jr. E.M.F. (1987). Cell and Molecular biology. Lea and Febiger, U. S.
7. Lee, C-H. (2009). Applied Molecular Biology. Kampus Books, Texas, USA.

PAPER IV: ENVIRONMENTAL BIOTECHNOLOGY MM. 75

UNIT I

1. Water, soil and air as a component of Environment.
2. Environment: Physico-chemical and biological characters.
3. Pollutants: Nature, origin, source, monitoring and their impacts.
4. Toxicology of common pollutants: Carcinogens and mutagens.

UNIT II

5. Water pollution: Industrial effluents, domestic wastes and agrochemicals.
6. Basic account of Air, soil and noise pollution.
7. Radiations as an environmental pollutant, hazards, monitoring and disposal.
8. Noise pollution and its impact on living system.

UNIT III

9. Types of solid wastes, transport, recycling, reuse and disposal for waste management.
10. Waste as a source of biofuels and biomass production.
11. Sewage treatment: Aerobic and anaerobic processes.

UNIT IV

12. Treatment scheme for waste water of dairy, distillery, tannery, sugar and antibiotic industries.
13. Environmental management, biological monitoring programme.
14. Impact assessment, bioleaching, biomineralization and biodegradation of xenobiotic compounds.

Books Recommended

1. Thakur, I.S. (2011). Environmental Biotechnology: Basic Concepts and Applications. IK International Publishing House Pvt. Ltd., New Delhi.
2. Mohapatra, P.K. (2006). Textbook of Environmental Biotechnology. IK International Publishing House Pvt. Ltd., New Delhi.
3. Fulekar, M.H. (2005). Environmental Biotechnology. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
4. Chatterji, A.K. (2011). Introduction to Environmental Biotechnology. PHI Learning Pvt. Ltd. New Delhi.
5. Rana, S.V.S. (2012). Environmental Biotechnology. Rastogi Publications, Meerut.

M. Sc. (Biotechnology) Semester-III Practical

PAPER I: INDUSTRIAL MICROBIOLOGY

1. Isolation and screening of bacteria/fungi and industrial importance (E.g. Protease or Amylase) from soil.
2. Production and estimation of citric acid.
3. UV survival curve and isolation of mutants.
4. Demonstration of replica plating techniques.
5. Demonstration of surface and submerged fermentations.
6. Study of design and working of a typical fermenter (lab scale).
7. Production of cellulose and ligninase from white rot fungi- *Pleurotus*.
8. Production and assay of alcohol by Yeast cells (free immobilized and packed bed bioreactor).

PAPER II: CELL AND TISSUE CULTURE

Plant Cell & Tissue culture

1. Micropropagation
2. Callus induction and somatic hybridization
3. Synthetic seed preparation
4. Anther and Ovule culture

Animal cell & Tissue culture

5. Short term lymphocyte culture
6. Long term fibroblast culture

PAPER III: APPLIED MOLECULAR BIOLOGY

1. Demonstration of PCR and analysis of abnormalities.
2. Native and SDS-PAGE
3. Karyotyping of abnormal individuals.
4. G-banding of human chromosomes.
5. Fluorescent (Q banding).

PAPER IV: ENVIRONMENTAL BIOTECHNOLOGY

1. Colour determination of water sample by Platinum Cobalt method.
2. Determination of transparency and turbidity of water sample.
3. Calculation of total solids and total dissolved solids in water sample.
4. Determination of dissolved oxygen (DO) by Winkler's method and free CO₂ in water sample.
5. Determination of BOD and COD of water sample.
6. Size determination of microphytes and estimation of Chlorophyll a and b in macrophytes.
7. Biomass, moisture, ash and organic matter estimation of macrophytes.
8. Determination of porosity, density and pH and colour of the soil sample.
9. Coliform test to check the microbiological quality of water.

**M.Sc. (BIOTECHNOLOGY) FINAL YEAR
FOURTH SEMESTER**

PAPER I: BIOCHEMICAL ENGINEERING

MM. 75

UNIT I

1. Scope and history
2. Microbial growth kinetics: Batch culture, Continuous culture, Fed-batch culture.

UNIT II

3. Transport phenomenon in bioprocess culture: Introduction, Oxygen requirement in Industrial fermentations. Oxygen supply and oxygen transfer rate. Factors affecting oxygen transfer rate. Determination of K_La values and factors affecting K_La values, Non-Newtonian fluids, Heat transfer and heat transfer correlations, Mass and energy balance.

UNIT III

4. Bioreactors: Ideal bioreactors, Reactor dynamics, Reactor with non-idea mixing, Sterilization reactors, Multiphase bioreactors, Animal and plant cell reactor technology, Instrumentation and control.
5. Method of measuring process variables: Temperature, Flow, Pressure, Dissolved oxygen, pH and other chemical factors.

UNIT IV

6. Control systems: Manual, Automatic, Computers and Interface.
7. Immobilization technology: Techniques and trends.

Books Recommended

1. Bailey, J.E. & Ollis, D.F. (2017). Biochemical Engineering Fundamentals. McGraw Hill Education.
2. Bailey, J.S. & Bhatia, S.C. (2009) Biochemical Engineering. CBS Publishers & Distributors, New Delhi.
3. Dutta, R. (2008). Fundamentals of Biochemical Engineering. Springer, India.
4. Doble, M. & Gummadi, S.N. (2007). Biochemical Engineering. PHI Learning Pvt. Ltd. New Delhi.
5. Rao, D.G. (2009). Introduction to Biochemical Engineering. McGraw Hill Education, New Delhi.

PAPER II: Ethics, Patenting and Bio-Entrepreneurship **MM. 75**

UNIT I:

1. **Ethics:** Benefits of biotechnology, ELSI of biotechnology, recombinant therapeutic products for human health care, genetic modifications and food consumption, release of genetically engineered organisms, applications of human genetic r DNA research, human embryonic stem cell research.

UNIT II:

2. **Patenting:** Patent and Trademark, Biotechnology products and processes, Intellectual property rights, Plant breeders rights, biotechnology in developing countries. Biosafety and its implementation, Quality control in Biotechnology.

UNIT III:

3. **Entrepreneurship:** definition, factors necessary for entrepreneurship, desirables in a startup, mistakes to be avoided, pillars of bio-entrepreneurship, promoting bio-entrepreneurship, biotech company roadmap, legal, regulatory and other business factors

UNIT IV:

4. **Funding of biotech business:** (Financing alternatives, VC funding, funding for biotech in India, Exit strategy, licensing strategies, valuation), support mechanisms for entrepreneurship (Bio-entrepreneurship efforts in India, difficulties in India experienced, organizations supporting biotech growth, areas of scope, funding agencies in India, biotech policy initiatives), Role of knowledge centers and R&D (knowledge centers like universities and research institutions, role of technology and upgradation)

Books Recommended

1. Dyson, A. & Harris, J. (2002). Ethics and Biotechnology (Social Ethics and Policy). Routledge Pub. (Kindle Edition)
2. Sherlock, R., Morrey, J.D., Agar, N. & Altieri, M. (2002). Ethical Issues in Biotechnology. Rowman & Littlefield Publishers. . (Kindle Edition)
3. Goel, D. & Parasar, S. (2013). IPR, Biosafety and Bioethics. Pearson Pub., New Delhi. . (Kindle Edition)
4. Gruber, A.C. (2009). Biotech Funding Trends. Wiley VCH.
5. Prasad, L. (2015). Patenting in India: Policy, Procedure and Public Funding. IK International Publishing House, New Delhi. . (Kindle Edition)

PAPER III: MEDICAL GENETICS

MM. 75

UNIT I

1. Pedigree analysis and monogenic traits: autosomal, sex-linked and sex-influenced traits, mitochondrial inheritance.
2. Complications to the basic pedigree patterns: non-penetrance, Pleiotropy, late onset, anticipation, genomic imprinting.
3. Monogenic disorders: cystic, fibrosis.
4. Inborn errors of metabolism: Phenylketonuria.

UNIT II

5. Genetic disorders of various systems.
 - a. Haematological disorders: Sickle cell anaemia, Thalassemys, Haemophilia.
 - b. Neurological disorders: Charcot-Marie tooth syndrome, Alzheimer's.
 - c. Muscular disorders: Duchenne muscular dystrophy, Baker's muscular dystrophy.
 - d. Eye disorders: Colour blindness, Retinitis pigmentosa.

UNIT III

6. Complex traits: Polygenic and multifactorial alcoholism, atherosclerosis, diabetes mellitus.
7. Chromosomal disorders: Human karyotype, banding and nomenclature, common syndromes due to numerical and structural alterations.
8. Syndromes due to triplet repeat expansion (Huntington's chorea, fragile X syndrome).

UNIT IV

9. Cancer: chromosomal disorders, oncogenes and tumor suppressor genes; Leukemia, retinoblastoma and breast cancer.
10. Introduction to genetic counseling: risk assessment, pre-implantation, pre-natal and post-natal diagnosis.
11. Legal and ethical consideration of testing and counseling.

Books Recommended

1. Pal, G.P. (2011). Medical Genetics. AITBS Publishers and Distributors, Delhi.
2. Prasad, B. (2016). Human Genetics for Medical and Life Sciences. Current Books International, Kolkata.
3. Gangane, S.D. (2017). Human Genetics. Elsevier, India, New Delhi
4. Thurmon, T.F. (1999). Medical Genetics. CRC Press, UK.
5. Datta, A.K. (2015). Essentials of Medical genetics. ARK Publications, Kolkata.