Department of Biotechnology
Institute of Biosciences and Biotechnology
Chhatrapati Shahu Ji Maharaj University, Kanpur

B.Sc. Syllabus (Biotechnology)
Three years degree course

B.Sc. Ist Year

Paper S. No.	Paper	Name of the Paper	Maximum Marks
Paper I	BBT-101	Biochemistry and Biophysics	100
Paper II	BBT-102	Cell Biology	100
Paper III	BBT-103	General Microbiology	100
Paper IV	BBT-104	Genetics	100
Paper V	BBT-105	Elementary Chemistry and Physics	100
Paper VI	BBT-106	Practicals	100

B.Sc. IInd Year

Paper S.No.	Paper	Name of the Paper	Maximum Marks
Paper I	BBT-201	Instrumentation and Bio-analytical Techniques	100
Paper II	BBT-202	Biomathematics and Biostatistics	100
Paper III	BBT-203	Molecular Biology	100
Paper IV	BBT-204	Immunology and Immunotechnology	100
Paper V	BBT-205	Computational Biology and Bioinformatics	100
Paper VI	BBT-206	Practicals	100

B.Sc. IIIrd Year

Paper S.No.	Paper	Name of the Paper	Maximum Marks
Paper I	BBT-301	Recombinant DNA Technology	100
Paper II	BBT-302	Plant Biotechnology	100
Paper III	BBT-303	Animal and Medical Biotechnology	100
Paper IV	BBT-304	Environmental and Industrial Biotechnology	100
Paper V	BBT-305	Genomics, Proteomics, Intellectual Property rights and Entrepreunership	100
Paper VI	BBT-306	Practicals	100

B.Sc. Syllabus Biotechnology
B.Sc.Ist Year

BBT-101
Paper First
Biochemistry and Biophysics (Max. marks:100)

Unit I: Chemical basis of life- Living matter composition; Water; Acids and bases; General properties of biomolecules in water.

Unit II: Bioenergetics: laws of thermodynamics (First and Second laws); Equilibria and concept of free energy; electrical properties of biological compartments, membrane potential, Energetics of a living body: Sources of heat limits to temperature, heat dissipation and conservation, high energy biomolecules (ATP, GTP and Creatine phosphate).

Unit III: Carbohydrates: General features and Structural aspects – Occurrence, Classification of Mono-, Di- and Polysaccharides, Reducing and Non-reducing Sugars, Constitution of Glucose and Fructose, Osazone formation, Pyranose and Furanose forms, Lipids : Introduction, Structural aspects –Classification and Structure of Simple and Compound lipids, Properties of Lipid aggregates, Biological membrane, Membrane protein – structural aspects, Lipoproteins.

Unit IV: Proteins : Introduction, Classification and General characteristics, Structure of Primary, Secondary, Tertiary and Quaternary proteins; Nucleic acid : Structural aspects – Components of DNA and RNA, Nucleosides and Nucleotides (introduction, structure and bonding), Double helical structure of DNA (Watson-Crick model), various forms of DNA.

Unit V: Physiological role of vitamins and minerals; Neurotransmitters and nervous system; Strategies of light reception in microbes, plants and animals, correction of vision faults, generation and reception of sonic vibrations, hearing as electrical properties of biological compartments.

Texts/References

1. V.Voet and J.G.Voet, Biochemistry, 3rd edition, John Wiley, New York, 2004.
2. A.L. Lehninger, Principles of Biochemistry, 4th edition, W.H Freeman and Company, 2004.
3. L. Stryer, Biochemistry, 5th edition, W.H. Freeman and Company, 2002.

BBT-102

Paper second

Cell Biology (Max. marks: 100)

Unit I: Cell a basic unit of living systems: the cell theory, pre-cellular evolution, artificial creation of cells; broad classification and Ultrastructure of cell types (PPLOs, Bacteria, eukaryotic microbes, plant and animal cells), tissue, organ and organism at different level of organization of other genetically similar cells. Function of cell and cell organelle: cytosol, golgi bodies, endoplasmic reticulum (rough and smooth), ribosomes, cytoskeletal structures (actin microtubules etc), mitochondria, chloroplast, lysosomes, peroxisomes, nucleus (nuclear membrane, nucleoplasm, nucleolus); Membrane structure- Structural models; Transport of ions and macromolecules.

Unit II : Chromatin organization (general overview), Cell division and Cell cycle: mitosis and meiosis, interphase, comparison of mitosis and meiosis, cell cycle regulation; Ecological amplitude of cells in high altitude, sediments, arctic, hot springs, arid, brackish and freshwater environments.

Unit III: Molecular mechanisms of membrane transport- nuclear transport, transport across mitochondria and chloroplasts; intracellular vesicular trafficking from endoplasmic reticulum through Golgi apparatus to lysosomes/cell exterior.

Unit IV: Cell signaling: Cell surface receptor, Hormones and receptors, Signaling through G-protein coupled receptors, signal transduction pathways, second messengers, Cell-cell interaction; Cell locomotion (amoeboid, flagellar and ciliary).

Unit V: Bacterial and plant two-component systems, muscle and nerve cells, Programmed cell death, aging and senescence.

Texts/References

1. Lodish et al., Molecular cell Biology, 4th Edition, W.H. Freeman & Company, 2000.
2. Smith & Wood, Cell Biology, 2nd Edition, Chapman & Hall, London, 1996.
3. Watson et al., Molecular Biology of the gene, 5th Edition, Pearson Prentice Hall. USA, 2003.
4. B. M. Turner, Chromatin & Gene regulation, 1st Edition, Wiley-Blackwell, 2002.
5. Benjamin Lewin, Gene IX, 9th Edition, Jones and Barlett Publishers, 2007.

BBT-103

Paper Third

General Microbiology (Max. marks:100)

Unit I: Pasteur's experiments; Koch -Germ Theory of diseases; Edward Jenner and Flemming (discovery of Penicillin), Scope of Microbiology; Concept of sterilization- methods of sterilization (dry heat, wet heat, radiation, chemical and filtration), Classification of bacteria; General characters of various forms of microorganism (bacteria, fungi, viruses, protozoa, PPLOs), Nature of microbial cell surfaces, Concept of species and strains; Mycobacteria and Mycoplasma; nutritional classification of microorganism.

Unit II: Staining and Mutations: Auxochrome, chromophores, dyes, Classification of stains, Theories of staining, Mechanism of gram staining: Gram positive and gram negative bacteria, acid fast staining, negative staining, capsule staining, flagella staining, endospore staining; Auxotrophs.

Unit III: Microbial agents of diseases: bacterial, viral, fungal and protozoan; Microbes in extreme environments: thermophiles and alkalophiles, Microbes-mechanism of evading defense response.

Unit IV: Host-pathogen interaction, ecological impact of microbes; symbiosis (Nitrogen fixation and ruminant symbiosis); microbes and nutrient cycles (Soil microorganisms and their importance in carbon and nitrogen cycles); microbial communication system; General overview of microbial fuel cells and Industrial microbes.

Unit V: General characteristics of viruses, differences between bacteria and viruses. Classification of viruses; viral replication, cultivation and identification of viruses; sub-viral particles – viroids and prions.

Text/ References:

1. Pelczar, M. J., Reid, R. D., & Chan, E. C. (2001). Microbiology (5th ed.). New York: McGraw-Hill.
2. Willey, J. M., Sherwood, L., Woolverton, C. J., Prescott, L. M., & Willey, J. M. (2011).Prescott's Microbiology. New York: McGraw-Hill.
3. Matthai, W., Berg, C. Y., & Black, J. G. (2005). Microbiology, Principles and Explorations. Boston, MA: John Wiley & Sons.

BBT-104

Paper Fourth

Genetics (Max. marks:100)

Unit I: Chromatin organization - Histone and DNA interactome; structural organization of chromatids, centromere, telomere, chromatin, nucleosome organization, Euchromatin and heterochromatin, special chromosomes (polytene, lampbrush chromosomes).

Unit II: Cytogenetics: Chromosome morphology, chemical composition, structural organization of chromatids, banding patterns in human chromosomes; Concept of gene: classical and modern gene concept, pseudoallelism; position effect, intragenic crossing over on rII locus in T4 phage.

Unit III: Mutations-spontaneous and induced: chemical and physical mutagens, induced mutations in plants, animal and microbes for economic benefit of man; Extra-chromosomal inheritance: Cytoplasmic inheritance, mitochondrial and chloroplast genetic systems.

Unit IV: Mendelian principles: Law of Segregation, Law of independent assortment, extension to mendelian segregation patterns, test cross, back cross, co-dominance, incomplete dominance, Lethality and gene interaction- Epistasis, multiple alleles, isoalleles and pseudo-isoalleles. Chromosomal basis of inheritance, chromosomal changes, inversion, duplication. male sterility. Genetics of sex determination and sex linked inheritance.

Unit V: Basic microbial genetics: conjugation, transformation, transduction and their uses in genetic mapping; Linkage and crossing over: Mapping of genes, interference, coincidence in pro- and eukaryotes.

Texts/References

1. Lodish et al., Molecular cell Biology, 4th Edition, W.H. Freeman & Company, 2000.
2. Smith & Wood, Cell Biology, 2nd Edition, Chapman & Hall, London, 1996.
3. Watson et al., Molecular Biology of the gene, 5th Edition, Pearson Prentice Hall. USA, 2003.
4. B. M. Turner, Chromatin & Gene regulation, 1st Edition, Wiley-Blackwell, 2002.
5. Benjamin Lewin, Gene IX, 9th Edition, Jones and Barlett Publishers, 2007.

BBT-105

Paper Fifth

Elementary Chemistry and Physics (Max. marks: 100)

Unit I: Chemistry: Atom and its structure; matter; elements, isotopes, atomic weights, atomic numbers, Avogadro number, molarity, gas constant, molecular weights, structural and molecular formulae, rates of reaction, rate constants, order of reactions, rate-determining steps, entropy and enthalpy changes during reactions; kinetic versus thermodynamic controls of a reaction, reaction equilibrium (equilibrium constant); Chemical bonds (ionic, covalent, Van der Walls forces); electronegativity, polarity; VSEPR theory and molecular geometry, dipole moment, orbital hybridizations; states of matter - vapor pressure, phase diagrams, surface tension, boiling and melting points, solubility, capillary action, suspensions, colloids and solutions.

Unit II: Acids, bases and pH - Arrhenious theory, pH, ionic product of water, weak acids and bases, conjugate acid-base pairs, buffers and buffering action etc; Chemical thermodynamics - first and second law, internal energy, heat and temperature, enthalpy (bond enthalpy and reaction enthalpy), entropy, Gibbs free energy of ATP driven reactions, spontaneity versus driven reactions in biology; redox reactions and electrochemistry - oxidation-reduction reactions, standard cell potentials, Nernst equation, resting membrane potentials.

Unit III: Physics-Physical quantities and their dynamics: definitions and dimensions; vectors and scalars, displacement, velocity, acceleration, kinematic formulas, angular momentum, torque etc. force, power, work, energy (kinetic and potential/electric charge separation, electromagnetic spectrum, photons etc.).

Unit IV: Newton's law of motions (centripetal and centrifugal forces etc.); frequency and wavelength; diffusion, dissipation, random walks, and directed motions in biological systems; Laws of thermodynamics: Maxwell Boltzmann distribution, conduction, convection and radiation; Coulomb's law, conductors and insulators, electric potential energy of charges, Ohms law (basic electrical quantities: current, voltage and power), electrolyte conductivity, capacitors and capacitance, dielectrics.

Text/ References:

1. Baaquie, B. E. (2000). Laws of Physics: a Primer. Singapore:
2. Matthews, C. P., & Shearer, J. S. (1897). Problems and Questions in Physics. New York: Macmillan Company.
3. Halliday, D., Resnick, R., & Walker, J. (1993). Fundamentals of Physics. New York: Wiley.
4. Ebbing, D. D., &Wrighton, M. S. (1990). General Chemistry. Boston: Houghton Mifflin.
5. Averill, B., & Eldredge, P. (2007). Chemistry: Principles, Patterns, and Applications. San Francisco: Benjamin Cummings.
6. Mahan, B. H. (1965). University Chemistry. Reading, MA: Addison-Wesley Pub.
7. Cantor, C. R., & Schimmel, P. R. (2004). Biophysical Chemistry. San Francisco:W.H. Freeman.

BBT-106

Practicals (Max. marks: 100)

B.Sc. Syllabus Biotechnology
B.Sc.IInd Year

BBT-201
Paper First
Instrumentation and Bioanalytical Techniques (Max. marks 100)

Unit I: Microscopy: Principle; Light microscopy, Phase contrast microscopy, dark-field, florescence and electron microscopy (TEM and SEM).

Unit II: Instruments, basic principle and usage: pH meter, Manometry, Palarography; Concept of Chromatography; partition coefficient; Partition Chromatography, TLC, Paper Chromatography, Ion Exchange Chromatography, Gel Chromatography, Adsorption Chromatography, Affinity Chromatography, GLC, HPLC.

Centrifugation: Basic Principle of Centrifugation (rpm, rcf), (Preparative, Analytical), different types of rotors; Factors affecting Sedimentation velocity, Standard Sedimentation Coefficient, Centrifugation of associating systems, Rate-Zonal centrifugation, density gradient centrifugation, sedimentation equilibrium; Instrumentation (Ultracentrifuge and Analytical).

Unit III: Electrophoresis: SDS-polyacrylamide gel electrophoresis, agarose gel electrophoresis, immunoelectrophoresis, isoelectric focusing.

Unit IV: Basic Principle; Absorption Spectroscopy – Simple theory of the absorption of light by molecules, Beer-Lambert law; Instrumentation for measuring the absorbance of visible light, UV-Visible spectroscopy- Principle, working and applications; colorimetry, atomic absorption, Circular dichroism- Principle and applications; IR spectroscopy; NMR and ESR Spectroscopy – Basic principle of NMR spectroscopy, Principle, working and applications, Chemical shift, Fluorescence spectroscopy, X-ray crystallography- Braggs equation, principle and applications**.**

Unit V: Radioisotope tracer technique (GM counting, scintillation counting), importance in biological studies, measurement of radioactivity, autoradiography.

Texts/References

1. Freifelder D., Physical Biochemistry, Application to Biochemistry and Molecular Biology, 2nd Edition, W.H. Freeman & Company, San Fransisco, 1982.
2. Keith Wilson and John Walker, Principles and Techniques of Practical Biochemistry, 5th Edition, Cambridge University Press, 2000.
3. D. Holme& H. Peck, Analytical Biochemistry, 3rd Edition, Longman, 1998.
4. R. Scopes, Protein Purification - Principles & Practices, 3rd Edition, Springer Verlag, 1994.
5. Selected readings from Methods in Enzymology, Academic Press.

BBT-202

Paper Second

Biomathematics and Biostatistics (Max. marks: 100)

Unit I: Relation and Functions, Mathematical Modeling, Complex numbers, Linear and Quadratic equations, Exponential and Logarithmic series. Matrices and Determinants, Boolean Algebra, Functions, Limits and continuity, Differentiation, Application of Derivatives, Differential Equations, Simple integrations.

Unit II: Fundamental concepts in applied probability; probability distributions (Binomial, Poisson and normal), Exploratory data analysis and statistical inference.

Unit III: Data collection and representation, Error analysis; Measures of central tendency and dispersal; Expectation and variance; Measures of spread: range, percentile, standard deviation; kurtosis, skew; frequency distributions; Discrete random variables: sampling, methods of sampling, advantages.

Unit IV: Sampling distribution; Difference between parametric and non-parametric statistics; Confidence Interval; Errors; Hypothesis testing: null and alternative hypothesis, confidence limit, level of significance, chi-square, F distributions, P-value of the statistic; Introduction to one way and two-way analysis of variance; Regression and Correlation.

Texts/References:

1. Wayne W. Daniel, Biostatistics : A foundation for Analysis in the Health Sciences, 8th Edition, Wiley, 2004.
2. Prem S. Mann, Introductory Statistics, 6th Edition, Wiley, 2006.
3. John A. Rice, Mathematical Statistics and Data Analysis, 3rd Edition, John A. Rice, Duxbury Press, 2006.
4. Campbell and Heyer, Discovering Genomics, Proteomics, & Bioinformatics, 2nd Edition, Benjamin Cummings, 2002.
5. Cynthia Gibas and Per Jambeck, Developing Bioinformatics Computer Skill, 1st Edition, O'Reilly Publication, 2001.

BBT-203
Paper Third
Molecular Biology **(Max. marks: 100)**

Unit I: Molecular basis of life: Structure and function of DNA and RNA; Organization of bacterial and eukaryotic chromosomes; Histone and DNA; Heterochromatin and Euchromatin; DNA reassociation kinetics (Cot curve analysis); DNase I hypersensitive regions; DNA methylation and Imprinting.

Unit II: Structure of DNA - A-,B-, Z- and triplex DNA; DNA replication in both prokaryotes and eukaryotes; DNA polymerases; Replication- initiation, elongation and termination in prokaryotes and eukaryotes; Enzymes and accessory proteins; Fidelity; Replication of single stranded circular DNA.

Unit III: Insertion elements and transposons: Transposable elements in *Drosophila* and maize; Organization of genetic material: split genes, overlapping genes, pseudo genes, cryptic genes.

Unit IV: Prokaryotic Transcription- Transcription unit; Properties of Promoters- Constitutive and Inducible promoters; prokaryotic gene expression (lac, his, trp operon, catabolite repression); Initiation; Attenuation; Termination; Eukaryotic transcription and regulation; RNA polymerase (RNA polymerase I, II, III); Eukaryotic promoters, trans-acting factors and enhancers; General Transcription factors; TATA binding proteins (TBP) and TBP associated factors (TAF).

Unit V: Translation machinery; Ribosomes; Composition and assembly; Universal genetic code; Degeneracy of codons; Termination codons; Wobble hypothesis; Mechanism of initiation, elongation and termination; Co- and post-translational modifications; Genetic code in mitochondria.

Text/References:

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., and Walter, P. (2008). Molecular Biology of the Cell (5th Ed.). New York: Garland Science.
2. Lodish, H. F. (2016). Molecular Cell Biology (8th Ed.). New York: W.H. Freeman.
3. Krebs, J. E., Lewin, B., Kilpatrick, S. T., & Goldstein, E. S. (2014). Lewin's Genes XI. Burlington, MA: Jones & Bartlett Learning.
4. Cooper, G. M., & Hausman, R. E. (2013). The Cell: a Molecular Approach (6th Ed.). Washington: ASM ; Sunderland.
5. Hardin, J., Bertoni, G., Kleinsmith, L. J., & Becker, W. M. (2012). Becker's World of the Cell. Boston (8th Ed.). Benjamin Cummings.
6. Watson, J. D. (2008). Molecular Biology of the Gene (5th ed.). Menlo Park, CA: Benjamin/Cummings.

BBT-204
Paper Fourth
Immunology and Immunotechnology (Max. marks:100)

Unit I: Immunology- Fundamental concepts and anatomy of the immune system; Components of innate and acquired immunity; Toll-like receptors, Inflammatory response; Haematopoesis; Organs and cells of the immune system- primary and secondary lymphoid organs-Bone marrow, thymus, lymph nodes, spleen; Mucosal and Cutaneous associated Lymphoid tissue (MALT and CALT); Mucosal Immunity; Antigens - haptens, antigenicity and immunogenicity.

Unit II: Humoral and Cell-Mediated Immune responses, primary and secondary immune modulation, Immunoglobulins: Basic structure, Classes and Subclasses of immunoglobulins, ADCC; complement mediated lysis, opsonization, antigenic determinants; B and T cells; Cell-mediated effector functions; Structure and function of antibody molecules.

Unit III: Major Histocompatibility Complex - MHC genes, MHC and immune responsiveness; endogenous antigens, exogenous antigens and super-antigens.

Unit IV: Antigen-antibody interactions- Kinetics of immune response; Precipitation, agglutination, Advanced immunological techniques; RIA, ELISA, Western blotting, ELISPOT assay, immunofluorescence, flow cytometry and immunoelectron microscopy; Introduction to Monoclonal antibodies and vaccines.

Unit V: Hypersensitivity – Introduction; Autoimmunity; Types of autoimmune diseases; congenital and acquired immunodeficiencies.

Texts/References:

1. Kuby, RA Goldsby, Thomas J. Kindt, Barbara, A. Osborne Immunology, 6th Edition, Freeman, 2002.
2. Brostoff J, Seaddin JK, Male D, Roitt IM., Clinical Immunology, 6th Edition, Gower Medical Publishing, 2002.
3. Janeway et al., Immunobiology, 4th Edition, Current Biology publications., 1999.
4. Paul, Fundamental of Immunology, 4th edition, Lippencott Raven, 1999.
5. Murphy, K., Travers, P., Walport, M., &Janeway, C. (2012). Janeway's Immunobiology. New York: Garland Science.
6. Kindt, T. J., Goldsby, R. A., Osborne, B. A., &Kuby, J. (2006). Kuby Immunology. New York: W.H. Freeman.

BBT-205

Paper Fifth

Computational Biology and Bioinformatics (Max. marks: 100)

Unit I: Local alignment, Global alignment, Scoring matrices - PAM, BLOSUM, Gaps and penalties, Dot plots.

Unit II: BLAST, FASTA. Building Profiles, Profile based functional identification; Polymorphisms in DNA sequence, Introduction to Next Generation Sequencing technologies, Whole Genome Assembly and challenges, Sequencing and analysis of large genomes, Gene prediction, Functional annotation, Comparative genomics.

Unit III: Probabilistic functional gene networks, Human genome project, Genomics and crop improvement. Study available GWAS, ENCODE, HUGO projects, extract and build sub databases; Visualization tools including Artemis and Vista for genome comparison; Functional genomics case studies.

Unit IV: Retrieving and drawing structures, Macromolecule viewing platforms, Structure validation and correction, Structure optimization, Analysis of ligand-protein interactions; Tools such as PyMol or VMD.

Unit V: Polymorphisms in DNA sequence, Introduction to Next Generation Sequencing technologies, Whole Genome Assembly and challenges, Sequencing and analysis of large genomes, Gene prediction, Functional annotation, Comparative genomics, Probabilistic functional gene networks, Human genome project, Genomics and crop improvement.

Texts/References:

1. Wayne W. Daniel, Biostatistics : A foundation for Analysis in the Health Sciences, 8th Edition, Wiley, 2004.
2. Prem S. Mann, Introductory Statistics, 6th Edition, Wiley, 2006.
3. John A. Rice, Mathematical Statistics and Data Analysis, 3rd Edition, John A. Rice, Duxbury Press, 2006.
4. Campbell and Heyer, Discovering Genomics, Proteomics, & Bioinformatics, 2nd Edition, Benjamin Cummings, 2002.
5. Cynthia Gibas and Per Jambeck, Developing Bioinformatics Computer Skill, 1st Edition, O'Reilly Publication, 2001.

BBT-206

Practicals (Max. marks: 100)

B.Sc. Syllabus Biotechnology
B.Sc.IIIrd Year

BBT-301
Paper First
Recombinant DNA Technology (Max. marks: 100)

Unit I: Basics Concepts- Restriction Enzymes; DNA ligase, Klenow enzyme, DNA polymerase, Polynucleotide kinase, Alkaline phosphatase; Cohesive and blunt end ligation; Linkers; Adaptors; Introduction to probes; Hybridization techniques: Northern and Southern blotting.

Unit II: Cloning Vectors - Introduction to cloning and expression vectors; Plasmids; Bacteriophages; PUC19 and Bluescript vectors, Phagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome (YACs; BACs); GST; pET-based vectors; Yeast vectors, Shuttle vectors.

Unit III: Cloning Methodologies- Insertion of Foreign DNA into Host Cells- Introduction of DNA into mammalian cells; Transfection techniques; Transformation; Construction of libraries; Isolation of mRNA and cDNA libraries; genomic DNA libraries; cDNA and genomic cloning.

Unit IV: PCR and Its Applications- Fidelity of thermostable enzymes; DNA polymerases; Types of PCR – multiplex, nested, reverse transcriptase, real time PCR, PCR in molecular diagnostics.

Unit V: Sequencing methods; Enzymatic DNA sequencing; Chemical sequencing of DNA; Automated DNA sequencing; Pyrosequencing; Applications of recombinant DNA technology; Genome editing tools and techniques; Gene silencing techniques; Introduction to siRNA; Micro RNA.

Text/References

1. S.B. Primrose, R.M. Twyman and R.W.Old; Principles of Gene Manipulation. 6th Edition, S.B.University Press, 2001.
2. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.
3. Brown TA, Genomes, 3rd ed. Garland Science 2006
4. Selected papers from scientific journals.
5. Technical Literature from Stratagene, Promega, Novagen, New England Biolab etc.

BBT-302
Paper Second
Plant Biotechnology (Max. marks: 100)

Unit I: Plant tissue culture: historical perspective; Culture Media: Preparation and Sterilization; nutrients and plant hormones; Cell and Tissue culture techniques; Subculturing; Cell Induction and Maintenance- totipotency; organogenesis; establishment of cultures – callus culture, cell suspension culture; Somatic embryogenesis.

Unit II: Tissue culture techniques – Micropropagation (clonal multiplication of elite species); Meristem culture; somaclonal variations; Haploid culture; androgenesis; ovary and ovule culture; Embryo culture; germplasm conservation and cryopreservation; endosperm culture and production of triploids; synthetic seed production; protoplast culture; somatic hybridization - methods and applications; cybrids and somatic cell.

Unit III: Genetic engineering: Agrobacterium-plant interaction; virulence; Ti and Ri plasmids; Genetic transformation - Agrobacterium-mediated gene delivery; direct gene transfer - PEG-mediated, electroporation, particle bombardment; screenable and selectable markers.

Unit IV: Characterization of transgenics; chloroplast transformation; molecular pharming - concept of plants as biofactories.

Unit V: Strategies for Introducing genes of biotic and abiotic stress resistance in plants; herbicides, insect resistance, production of secondary metabolites, biotransformation.

Text/Reference Books:

1. Chawla, H. S. (2000). Introduction to Plant Biotechnology. Enfield, NH: Science.
2. Razdan, M. K. (2003). Introduction to Plant Tissue Culture. Enfield, NH: Science.
3. Slater, A., Scott, N. W., & Fowler, M. R. (2008). Plant Biotechnology: an Introduction to Genetic Engineering. Oxford: Oxford University Press.
4. Buchanan, B. B., Gruissem, W., & Jones, R. L. (2015). Biochemistry & Molecular Biology of Plants. Chichester, West Sussex: John Wiley & Sons.
5. Umesha, S. (2013). Plant Biotechnology. The Energy And Resources.
6. Glick, B. R., & Pasternak, J. J. (2010). Molecular Biotechnology: Principles and Applications of Recombinant DNA. Washington, D.C.: ASM Press.
7. Brown, T. A. (2006). Gene Cloning and DNA Analysis: an Introduction. Oxford: Blackwell Pub.
8. Primrose, S. B., &Twyman, R. M. (2006). Principles of Gene Manipulation and Genomics. Malden, MA: Blackwell Pub.
9. Slater, A., Scott, N. W., & Fowler, M. R. (2003). Plant Biotechnology: The Genetic Manipulation of Plants. Oxford: Oxford University Press.

BBT-303

Paper Third

Animal and Medical Biotechnology (Max. marks: 100)

Unit I: Animal cell culture: brief history of animal cell culture; cell culture media and reagents; culture of mammalian cells, tissues and organs; primary culture, secondary culture, continuous cell lines, suspension cultures; application of animal cell culture; Transgenic animals; Knockout mice and their applications.

Unit II: Vaccine technology: Immunity and vaccine; Herd Immunity; Rationale vaccine design based on clinical requirements: Active immunization, Attenuated; Inactivated; Subunit vaccines; Recombinant and protein based vaccines, plant-based vaccines; conjugate vaccines; Passive Immunization; Monoclonal Antibody production and applications: Hybridoma and Phage display.

Unit III: Important therapeutic proteins: Functions, Uses and Production of- Insulin, Growth Hormone, Alpha-1-antitrypsin, Factor VIII, Tissue-Plasminogen Activator, Erythropoietin; Interferons.

Unit IV: Biotechnological methods of disease diagnosis and treatment- Microbiological; Immunological; Serological; Molecular diagnostics-PCR, Microarray technology; Basic concept of Pharmacogenomics; Forensic medicine: DNA fingerprinting and DNA profiling.

Unit V: Drug targeting and delivery; In vitro fertilization and Embryo Transfer; Cryopreservation of sperm and ovum; Stem Cell therapy; Gene therapy; Production of Artificial tissues and organs.

Texts/References

1. F.C. Hay, O.M.R. Westwood, Practical Immunology, 4th Edition-, Blackwell Publishing, 2002
2. S. Hockfield, S. Carlson, C. Evans, P. Levitt, J. Pintar, L. Silberstein, Selected Methods for Antibody and Nucleic Acid probes, Volume1, Cold Spring Harbor Laboratory Press,1993.
3. Ed Harlow, David Lane, Antibodies Laboratory Manual, Cold Spring Harbor, Laboratory Press, 1988.
4. Gupta V et al (2016) Basics and Applied aspects of Biotechnology, Springer International.
5. Gordon, I. (2005). Reproductive Techniques in Farm Animals. Oxford: CAB International.
6. Levine, M. M. (2004). New Generation Vaccines. New York: M. Dekker.
7. Pörtner, R. (2007). Animal Cell Biotechnology: Methods and Protocols. Totowa, NJ: Humana Press.

BBT-304
Paper Fourth
Industrial and Environmental Biotechnology (Max. marks: 100)

Unit I: Basic principles in bioprocess technology; Isolation, screening and maintenance of industrially important microbes; Microbial growth and death kinetics; Media Formulation; Sterilization; Bioreactor designs; Types of fermentation and fermenters; Concepts of basic modes of fermentation - Batch, fed batch and continuous. Primary and secondary metabolites.

Unit II: Enzyme Technology-production, recovery, bacterial and fungal enzymes-amylase, protease, penicillin acylase, glucose isomerase; Immobilised Enzyme and Cell based bio transformations; Applications of enzymes.

Unit III: Waste water management: domestic, industrial, solid and hazardous wastes; strain improvement; Water usage and recycling; Effluent treatment and disposal; Biocomposting.

Unit IV: Introduction to environment; pollution and its control; pollution indicators; Biodiversity and its conservation; Bioremediation: Fundamentals, methods and strategies of application (biostimulation, bioaugmentation); Phytoremediation: Fundamentals and description of major methods of application (phytoaccumulation, phytovolatilization, rhizofiltrationphytostabilization); Biocomposting.

Unit V: Bioinsecticides: Bacillus thuringiensis, Baculoviruses. Biofungicides: Description of mode of actions and mechanisms; Biofertilizers; Symbiotic systems between plants – microorganisms (nitrogen fixing symbiosis, mycorrhiza fungi symbiosis); Biofuels; Bioleaching of metals; Production of bioplastics, biosurfactants: bioemulsifiers.

Texts/References

1. Dr. Murray Moo-Young (Ed), Comprehensive Biotechnology: 4-Volume
2. Allan Whitaker, Peter F. Stanbury, and Stephen J. Hall, Principles of Fermentation Technology.
3. Daniel A. Vallero, Environmental Biotechnology: A Biosystems Approach
4. Lawrence K. Wang, Environmental Biotechnology

BBT-305
Paper Fifth
Genomics, Proteomics, Entrepreneurship,
Intellectual Property rights and Product Regulation (Max. marks: 100)

Unit I: Introduction: Structural organization of genome in Prokaryotes and Eukaryotes; Organellar genome--mitochondrial, chloroplastic; Recognition of coding and non-coding sequences and gene annotation. Physical and Genetic Mapping; Human Genome Project, Accessing and retrieving genome project information from web; Comparative genomics.

Unit II: Proteomics: Protein analysis by N-terminal sequencing and 2-D electrophoresis of proteins; LC/MS-MS for identification of proteins and modified proteins; MALDI-TOF.

Unit III: Pharmacogenetics: High throughput screening in genome for drug discovery-identification of gene targets, Rational Drug designing and development.

Unit IV: Introduction to Intellectual Property; Types of IP: Patents (Basics of Patents; Types of patents; Indian Patent Act 1970; Recent Amendments; Filing of a patent application; Precautions before patenting-disclosure/non-disclosure; Patent filing and Infringement; Trademarks, Copyright and Related Rights, Industrial Design, Entrepreneurship -Few Case Studies.

Unit V: Biosafety Introduction; Historical Backround; Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals; GMOs and LMOs.

Texts/References

1. Voet D, Voet JG & Pratt CW, Fundamentals of Biochemistry, 2nd Edition. Wiley 2006
2. Brown TA, Genomes, 3rd Edition. Garland Science 2006
3. Campbell AM &Heyer LJ, Discovering Genomics, Proteomics and Bioinformatics, 2nd Edition. Benjamin Cummings 2007
4. Primrose S &Twyman R, Principles of Gene Manipulation and Genomics, 7th Edition, Blackwell, 2006.
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Practicals