

**D.R. BABASAHEB AMBEDKAR
MARATHWADA UNIVERSITY,
AURANGABAD.**



**Revised Syllabus of
B.Sc. FIRST & SECOND YEAR
BIOTECHNOLOGY [OPTIONAL]**

Semester-I to IV

[Effective for 2014-15]

General Outline of courses/papers offered for Degree in B. Sc. Biotechnology

(Optional) (2014-15 onwards)

Sr. No	Paper/Course code	Title of the course / Paper	Credits	Marks
B. Sc. First Year, Semester I				
1.	I-MBO	Microbiology	3	50
2.	II-BCB	Biomolecules & Cell Biology	3	50
3.	III-LC1	Microbiology and Biomolecules	1.5	50
B. Sc. First Year, Semester II				
4.	IV-GTS	Genetics	3	50
5.	V-BMT	Biomathematics & Biostatistics	3	50
6.	VI-LC2	Cell Biology and Genetics	1.5	50
B. Sc. Second Year, Semester III				
7.	VII-MTB	Metabolism	3	50
8.	VIII-MOG	Molecular Genetics	3	50
9.	IX-LC-3	Metabolism	1.5	50
10.	X-LC-4	Molecular Genetics	1.5	50
B. Sc. Second Year, Semester IV				
11.	XI-EBT	Environmental Biotechnology	3	50
12.	XII-EZY	Enzymology	3	50
13.	XIII-LC-5	Environmental Biotechnology	1.5	50
14.	XIV-LC-6	Enzymology	1.5	50
B. Sc. Third Year, Semester V				
15.	XV-BPE	Bioprocess Engineering	3	50
16.	XVI-RDT	Recombinant DNA Technology	3	50
17.	XVII-LC-7	Bioprocess Engineering	1.5	50
18.	XVIII-LC-8	Recombinant DNA Technology	1.5	50
B. Sc. Third Year, Semester VI				
19.	XIX-MBT	Microbial Biotechnology	3	50
20.	XX-BIN	Bioinformatics	3	50
21.	XXI-LC-9	Microbial Biotechnology	1.5	50
22.	XXII-LC-10	Bioinformatics	1.5	50

B.Sc. Biotechnology (Optional) First Year, I & II Semester

B. Sc. First Year, Semester I

Paper I - MBO Microbiology

Credits:3

Marks: 50

Unit: 1

Scope of Microbiology: Microorganisms in human affairs and industry.

History of Microbiology: Contributions of Anton van Leeuwenhoek, Joseph Lister, Paul Ehrlich, Edward Jenner, Louis Pasteur, Robert Koch and Alexander Fleming. **Prokaryotic Cell:** Cell wall. Distinction between cell wall of Gram positive and Gram negative bacteria. Cell membrane, Cytoplasm, nucleoid, endospore, flagella, pili, glycocalyx. Structure of Achaea cell.

Unit: 2

Diversity of Microorganisms: General account of Bacteria, Fungi, Protozoa, Algae and Viruses. Taxonomy: Naming of microorganisms. Contribution of C. Linnaeus, Taxonomy hierarchy, Whittaker's five kingdom and Carl Woese's three domain classification system. Classification of bacteria and cyanobacteria: Bergery's Manual of Systematic Bacteriology. Classification of Fungi and Protistean Algae.

Unit: 3

Visualisation of Microorganisms: Principle and structure of Light Microscope, Numerical Aperture, Resolving Power. Magnification. Principle and structure of electron microscope (SEM and TEM). Comparison between light and electron microscope. **Preparation and staining of specimens for light microscopy:** Fixation, Dyes and simple staining, Differential staining- Gram staining, acid-fast staining, Staining specific structures-negative staining, endospore staining, flagella staining.

Unit: 4

Microbial Nutrition: Common nutrient requirements, Nutritional types of microorganisms, growth factors. Uptake of nutrients by cells. Culture Media: Synthetic or defined media. Commonly used media. Types of Media- Selective, differential and enrichment media. **Aseptic Techniques:** Disinfection, Sterilization. Cultivation of bacteria, fungi and viruses. Pure culture: Concept of pure culture. Methods of pure culture of microorganisms – Spread plate, streak plate and pour plate.

References:

1. Keshav Trehan Biotechnology, Willey Eastern Ltd. New Delhi, 1990.
2. Alan Wiseman, Principles of Biotechnology, Surrey University press, 1983.
3. General Microbiology by Stanier.
4. Microbiology by Pelzar.
5. General Microbiology Powar and Dagainawala.
6. Microbiology and Introduction by TorTora Funke, Case.
7. The world of the cell, Becker, Kleinsmith, Hardin.

Paper II - BCB Biomolecules & Cell Biology

Credits: 3

Marks: 50

Unit: 1

Chemistry of Living Cell: Cell & its components, various classes of biological molecules & functions, Chemicals inside the cell-Large & small molecules Origin of life: Origin of amino acids, Nucleotides, Urey Miller's Experiment.

Unit: 2

Amino acid & Protein: Structural classification of amino acids based on R side chain, Structural levels of Proteins, Classification of Proteins based on Composition, Functions of Proteins. Carbohydrates:- General classification of Carbohydrates, Structural Classification of Monosaccharides, Ring formation in Monosaccharides, Mutarotation, Oligosaccharide Glycosidic bond, Disaccharides (Sucrose, Maltose, Lactose) Polysaccharides (e.g. Starch, Glycogen, Cellulose, Heparin, Pectin), Biological functions of Carbohydrates. Molecules involved in generation of Mechanical Stability: Peptidoglycan, Polysaccharide (Cellulose in Plant).

Unit: 3

Membrane lipid, Definition of lipid. Examples of membrane lipid Phospholipids, Sphingolipid.

Membrane models- Overton's lipid nature of membrane, Langmuir's lipid monolayer, Gorter and Grendel's lipid bilayer, Davson and Danielli's lipid bilayer plus protein sheet, Robertson's Unit membrane, Singer and Nicolson's fluid mosaic. **Membrane structure**- 2D Lipid bilayer, composition of lipid bilayer, asymmetric nature, fluidity, membrane proteins and their function.

Membrane Transport: Movement across membranes- **Passive transport**: simple diffusion, facilitated diffusion-transporters (uniporters and Cotransporters) and channel proteins. **Active transport**: Pumps, Group Translocation and Electrochemical Gradients. Protein sorting and intracellular compartments- Vesicular transport; transport of proteins into mitochondria, Vesicular traffic in the secretory and endocytic pathway

Unit: 4

Structure and Functions of Organelles: Endoplasmic Reticulum, Lysosome, Golgi Complex, Peroxisome (Microbody), Centriole, Mitochondria, Cytoskeleton- microtubules, intermediate filaments, actin filaments, mechanism of muscle contraction, motors and movements, Cilia & Flagella, Nucleus, Cell division & cell cycle: i) Mitosis ii) Cell cycle- a) interphase b) G1 Phase c) G2 Phase d) Mitosis iii) Meiosis

References:

1. Outline of Biochemistry V ed. Conn and Stumpf, John Wiley and sons.
2. Biochemistry S.C. Rastogi, Tata McGraw Hill pub. Co, New Delhi.
3. Cell and molecular biology- Arumugham.
4. Cell and molecular biology- De Robertis
5. Cytology genetics and evolution- Agarwal and varma

Paper III - LC1 Microbiology and Biomolecules

Credits: 1.5

Marks: 50

1. Basic staining techniques-Monochrome staining, Differential staining Grams staining., Acid fast staining
2. Preparation of nutrient media-Nutrient broth, Nutrient agar, Mac Conkey's agar.
3. Study of aerobic and anaerobic microflora
4. Study of yeast, fungi.
5. Isolation technique, streak, pour, spread plate.
6. Effect of pH on growth of bacteria.
7. Isolation of alkalophilic, halophilic and thermophilic organisms.
8. Enumeration of bacteria by Breed's count method.
9. Estimation of amino acid by ninhydrin method.
10. Estimation of protein by Biuret method & Lowry method.
11. Estimation of glucose by DNS method, Benedict's titrimetric method.
12. Estimation of total carbohydrates by anthrone method.
13. Isolation of egg albumin from egg white.
14. Isolation of cholesterol from egg yolk.
15. Isolation of starch from potatoes.
16. Isolation of casein from milk.
17. Separation of amino acids by paper chromatography.
18. Separation of serum proteins by paper electrophoresis.
19. Separation of plant pigments by TLC.

B. Sc. First Year, Semester II

Paper IV- GTS Genetics

Credits: 03

Marks: 50

Unit: 1

Introduction to genetics: Genotype and Phenotype. A brief overview of Mendel's Laws of Inheritance. DNA as Genetic material- Experimental proof. Structure and types of DNA and RNA. Properties of nucleic acids. Physical Basis of inheritance: Chromosome theory of inheritance. Eukaryotic Chromosome – Macromolecular Organization. Chromosome types –primary and secondary constrictions. Sat – bodies, Telomeres. Heterochrom at in and Euchromatin and its significance. Ultrastructure of Chromosome – Karyotype and Idiogram. Special types of chromosomes Polytene chromosomes – Salivary gland chromosomes in Drosophila, Lampbrush Chromosomes in amphibian Oocytes & B Chromosomes.

Unit: 2

Sex Linkage: Meiotic behaviour of chromosomes and non-disjunction. Bridges theories of non-disjunction. Sex-linkage in Drosophila. Sex linked genes in Poultry and Moths. Sex related genes in maize. Attached X-chromosome. Linkage: Coupling and repulsion hypothesis. Linkage in maize and Drosophila, Linkage groups, Complete linkage, incomplete linkage, factors affecting linkage – distance, age, temperature, X-rays, etc. Theories of linkage, differential multiplication theory and chromosome theory. Measurement of linkage from T2 Bacteriophage. Cis-Trans arrangement. Linkage maps in Maize and Drosophila.

Unit: 3

Crossing over: Mechanism of crossing over. Cytological theories of crossing over. Germinal and Somatic crossing over. Crossing over in Drosophila, absence of crossing over in male Drosophila. Frequency and percentage of crossing over. Tetrad analysis in Neurospora. Interference and Coincidence. Construction of genetic maps (Drosophila and Maize)

Unit: 4

Chromosomal aberrations:Numerical: Euploidy (Monoploidy, Hap loidy and Polyloidy) Polyploidy – autopolyploidy and allopolyploidy Aneuploidy – Monosomes, Nullisomes, & Trisomes. Structural: Deletions, Duplications, Translocations and Inversions. Evolutionary significance of chromosomal aberrations.

References:

1. Genetics Peter J Russel, The Benjamin/ Qummin publishing Co.
2. Principles of Genetics by Gardner, Siemens.
3. Molecular Genetics by Friefeder.
4. Molecular biology laboratory manual 6th Edn, Cappuccino.
5. Molecular biology and the gene Watson.
6. Genetics. Strickberger M.W.
7. Genetics Goodenough U

Paper V-BMT Biomathematics & Biostatistics

Credits: 03

Marks: 50

Unit: 1

Maths:

Sets: Definition, Subset. Union, intersection, Venn Diagrams, Complement of a Set, Universal Set, Distributive laws & De Morgan's Law (Verification by simple examples no proof is expected product of Sets) Functions:- Definition Graphs of 1) Linear function 2) Power function 3) Quadratic function 4) Periodic function 5) Exponential function. Use of Logarithms for simple problems (Without log tables) Binomial Theorem (Without proof) – Simple Examples

Unit: 2

Limits of a function: Concept of limit, Limit of function at a point, Simple algebraic limits. Derivative/ Differentiation- Derivative of simple algebraic functions. Derivatives of standard Trigonometric & Logarithmic functions (without proof) Addition rules, Subtraction rules, Product rule (Treatments only) Integration:- Integration as antidifferentiation, Problems involving simple polynomial functions.

Unit: 3

Biostatistics:

Probability: Random Experiment, Sample space, Event, Probability of an Event, Axioms of probability. Measures of central Tendencies: Mean, Calculation of Mean of ungrouped & grouped data Mode & Median of ungrouped data.

Unit: 4

Measures of deviation, Mean deviation & Standard deviation (For Ungrouped Data) Sampling: Types of Sampling- Purposive sampling, Random sampling, Simple sampling & Stratified sampling.

References:

1. Introduction to Mathematics for Life Science-E.Batschelet, Narosa Publishing house New Delhi,1975(II Edition)
2. Fundamentals of Mathematical Statistics-S.C.Gupta& V.K.Kapur, S. Chand Publication

Paper VI – LC2 Cell Biology and Genetics

Credits:1.5

Marks: 50

1. Study of epidermal hair system from different plants
2. Study of stomatal apparatus
3. Study of simple and complex plant tissue system
4. Mitosis and Meiosis using onion root tips
5. Study of Giant Chromosomes
6. Cell wall staining of plant cell
7. Study of cell inclusion starch
8. Study of Cyanobacteria cell with heterocyst
9. Staining the epithelial cell of mouth using Giemsa
10. Testing the viability of spores, tissues using hydrogen peroxide
11. Floral structure of pea plant and Maize/Arabidopsis
12. Temporary squash preparations of Onion flower buds.
13. Study of variations in Pea Plant : Flower Color in Antirrhinum & Mirabilis
14. Computation of mean, mode, median, standard deviation and standard error.
15. Genetic Problems : Multiple alleles
16. Application of Chi-square test, t test and F test

B.Sc. Biotechnology (Optional) Course Syllabus

B. Sc. Second Year

Semester III

Paper VII-MTB Metabolism

Credits: 03

Marks: 50

Unit: 1

Catabolism and the generation of chemical energy, metabolic strategies, general principles of intermediary metabolism, regulation of pathways, strategies for pathway analysis. Glycolysis, gluconeogenesis and the pentose phosphate pathway, regulation of glycolysis and gluconeogenesis, the pentose phosphate pathway, discovery of the TCA cycle, steps in the TCA cycle, stereochemical aspects of TCA cycle reactions, ATP stoichiometry of the TCA cycle, the glyoxylate cycle oxidation of other substrates by the TCA cycle, regulation of TCA cycle activity.

Unit: 2

The mitochondria, electron transport chain, oxidative phosphorylation, transport of substrates, Pi, ADP and ATP into and out of Mitochondria, Electron transport and ATP synthesis in bacteria.

Unit: 3

Pigments involved in photosynthesis, photoreduction of NAD^+ , light reaction in blue green algae and photosynthetic eukaryotes, dual pigment systems, photosynthetic electron transport, efficiency of light reaction, Calvin cycle, efficiency of dark reaction, comparison of photosynthesis in bacteria, blue green algae and eukaryotes. C_4 pathway for CO_2 fixation.

Unit: 04

Metabolism of Fatty Acids: Fatty Acid Degradation, Biosynthesis of Saturated Fatty Acids, Regulation of Fatty Acid Metabolism.

References:

1. Biochemistry by Lubert Stryer
2. Biochemistry by Lehninger
3. Biochemistry by Zubey
4. Comprehensive Biotechnology (Vol. 1-4): M.Y.Young (Eds), Pergamon press, Oxford

Paper VIII-MOG Molecular Genetics

Credits: 03

Marks: 50

Unit: 1

Structure of nucleic acid, eukaryotic nuclear genomes, packaging of DNA into chromosome types, pseudogenes and other gene relics, eukaryotic organelle genomes, physical features and genetic content of organelle genomes, the repetitive DNA content of genomes. Tandomly repeated DNA, Transposons, anatomy of prokaryotic genome: Physical structure, operon concept

Unit: 2

Genome replication: The issues relevant to genome replication, the topological problem, Watson – Crick scheme of DNA replication, variations in semi-conservative theme, DNA topoisomerae. The replication process: initiation, elongation and termination of replication, the diverse functions of topoisomerase, regulation of Eukaryotic genome replication.

Unit: 3

Pseudogenes, synthesis and processing of Non-coding RNA, introns in eukaryotic pre rRNA and pre tRNA. Processing of Pre-RNA by chemical modification, RNA editing, turnovers of mRNAs. Synthesis and processing of the Proteome: Role of tRNA in protein synthesis, amino acylation and Codon-anticodon interaction.

Unit: 4

The genetic code, origin and evolution of Genetic code, ribosome structure, translation, regulation of translation, translation in archea Post-translational processing of proteins, frame shifting, protein folding. Processing by proteolytic cleavage, processing by chemical modification, protein turnover, and degradation of Ubiquitin tagged proteins in the proteasome.

References:

1. Molecular cloning, Sambrook et al, cold spring harbor.
2. Essentials of Molecular Biology, Malacinski and Friefelder Jones and Bartlelt
3. Genomes, T A Brown, John Wiley and sons PTE Ltd.
4. Cell and Molecular Biology, concepts and experiments, Gerald Karp, John Wiley and sons.
5. The cell- A molecular approach, Gm Cooper Asm Press.

Paper IX-LC-5 Metabolism

Credits:1.5
50

Marks-

1. Introduction to measurements: balances and pipetting. Preparation of solutions of given normality and its standardization.
2. pH meter: buffering capacity of a buffer, indicators.
3. To determine the pKa value and hence the Dissociation constant of a given acid by using pH meter.
4. Determination of the amount of α -amino nitrogen by the formol titration method.
5. Colorimetry: To determine dissociation constant of a given indicator, calorimetrically and to prepare buffer solutions in the pH range of 2.2 to 8.0
6. Spectrophotometry: Double- beam and recording spectrophotometry, derivatives and difference spectra: Indicators, cytochromes, haemoglobin. To find out the absorption spectrum of a given chromophore and / or oxidized and reduced forms (sodium nitrite and borohydrate).
 - a) Haemoglobin and methemoglobin
 - b) NAD and NADH
 - c) Spectrophotometer absorption spectrum, activity of the fraction.

Paper X-LC-6 Molecular Genetics

Credits: 1.5
50

Marks:

1. Study of conjugation in *E. coli*
2. Study of transduction in *E. coli*
3. Plasmid gene mapping in *E. coli*
4. Tns-5 induced mutagenesis in *E. coli*
5. Study of mutation in *E. coli*
6. Isolation of plasmid DNA from different type of bacteria by adopting different methods, purification and calculation of molecular weight of plasmid DNA, plasmid curing (acridine orange, heat shock)
7. Isolation of genomic DNA from bacteria
8. Isolation of Genomic DNA from plant cells / animal cells

Semester IV

Paper XI-EBT Environmental Biotechnology

Credits: 03

Marks: 50

Unit: 1

Introduction to Ecology and ecosystem. Environmental pollution (Water, soil and Air), noise and thermal pollution, their sources and effects. Waste water (sewage and industrial effluents) treatments: anaerobic and aerobic treatment, conventional and advanced treatment technology, methanogenesis, methanogenic, acetogenic and fermentative bacteria- technical process and condition, emerging biotechnological processes in waste- water treatment.

Unit: 2

Solid waste management: Landfills, composting, earthworm treatment, recycling and processing of organic residues.

Unit: 3

Biodegradation of xenobiotic compounds, organisms involved in degradation of chlorinated hydrocarbons, substituted simple aromatic compounds, polyaromatic hydrocarbons, pesticides, surfactants and microbial treatment of oil pollution.

Unit: 4

Microbial leaching and mining: Extraction of metals from ores, recovery of metals from solutions, Microbes in petroleum extraction, Microbial desulfurization of coal. Wasteland: Uses and management, bioremediation and biorestitution of contaminated lands.

References:

1. Environmental Microbiology; W D Grant & P E Long, Blakie, Glasgow and London
2. Microbial Gene Technology: H Polasa (ED) South Asian Publishers, New Delhi.
3. Biotreatment Systems, Vol. 22, D L Wise (Ed) CRC Press, INC
4. Standard Methods for the examination of water and waste water (14th Edition) 1985. American Public Health Association

Paper XII-EZY Enzymology

Credits: 03Marks: 50

Unit: 1

Classification - IUB system, rationale, overview and specific examples. Characteristics of enzymes, enzyme substrate complex. Concept of active centre, binding sites, stereospecificity and ES complex formation. Effect of temperature, pH and substrate concentration on reaction rate. Activation energy. Transition state theory. Enzyme activity, international units, specific activity, turnover number, end point kinetic assay

Unit: 2

Enzyme Kinetics: Michaelis - Menten Equation - form and derivation, steady state enzyme kinetics. Significance of V_{max} and K_m . Bisubstrate reactions. Graphical procedures in enzymology - advantages and disadvantages of alternate plotting. Enzyme inhibition - types of inhibitors - competitive, noncompetitive and uncompetitive, their mode of action and experimental determination.

Unit: 3

Enzyme Regulation: Product inhibition, feedback control, enzyme induction and repression and covalent modification. Allosteric regulation.

Unit: 4

Immobilized enzymes and cells: Relative practical and economic advantage for industrial use, various methods of immobilization - ionic bonding, adsorption, covalent bonding (based on R groups of amino acids) , microencapsulation and gel entrapment. Immobilized multienzyme systems Biosensors - glucose oxidase, cholesterol oxidase, urease and antibodies as biosensors

References:

1. Enzymes: Dixon and Webb. IRL press.
2. Principles of Enzymology for technological Applications (1993): Butterworth Heinemann Ltd. Oxford
3. Enzymes in Industry: Production and applications: W Gerhartz (1990), VCH Publishers, New York.
4. Biocatalyst for Industry: J S Dordrick (1991), Plenum press, New York.
5. Enzyme Technology-M F Chaplin and Bucke, Cambridge University Press, Cambridge
6. Fundamentals of Enzymology by Princes and Stevens, Oxford Press.

Paper XIII-LC-7 Environmental Biotechnology

Credits: 1.5

Marks:

50

1. Isolation of rhizosphere microflora
2. Isolation of phylloplane
3. Isolation of actinomycetes from soil
4. Isolation of Rhizobium and Agrobacterium
5. Vessicular Arbuscular Mycorrhiza (VAM)
6. Isolation of sporocarp by sieve method
7. Isolation of air microflora- exposure plate method, rotorod sampler method
8. Water Microbiology Testing for quality of water (coliform test), H₂S strip method

Paper XIV-LC-8 Enzymology

Credits: 1.5

Marks: 50

1. Enzyme assays (LDH, beta galactosidase, acid phosphatase, arginase, succinic dehydrogenase)
2. Effect of time, temperature, and protein concentration on enzyme activity
3. Determination of K_m & V_{max}
4. Various kinetic plots : use of computer packages for parametric and non- parametric methods and non-linear regression

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