Telangana State Council of Higher Education, Govt. of Telangana

B.Sc - CBCS

Common Core Syllabi for all Universities in Telangana

B.Sc –BIOTECHNOLOGY

(2019 onwards)

Telangana State Council of Higher Education, Govt. of Telangana B.Sc.,
CBCS Common Core Syllabi for all Universities inTelangana
B.Sc - Biotechnology (*wef* 2019)

CODE	COURSE TITLE	COURSE TYPE	HPW	CREDITS
	FIRST YEAR- SEMESTER I			
BS 101	Environmental Science/Basic Computer Skills	AECC-1	2	2
BS 102	English	CC-1A	4	4
BS 103	Second language	CC-2A	4	4
BS 104	**Optional I- Cell biology and Genetics**	**DSC-1A**	**4T+3P=7**	**4+1=5**
BS 105	Optional II	DSC-2A	---------	4+1=5
BS 106	Optional III	DSC-3A	---------	4+1=5
	TOTAL			**25**
	FIRST YEAR- SEMESTER II			
BS 201	Gender Sensitization	AECC-2	2	2
BS 202	English	CC-1B	4	4
BS 203	Second language	CC-2B	4	4
BS 204	**Optional I- Biological Chemistry and Microbiology**	**DSC-1B**	**4T+3P=7**	**4+1=5**
BS 205	Optional II	DSC-2B	-----	4+1=5
BS 206	Optional III	DSC-3B	-------	4+1=5
	TOTAL			**25**
	SECOND YEAR- SEMESTER III			
BS 301	**SEC 1: Industrial Fermentations**	**SEC-1**	**2**	**2**
BS 302	**SEC 2: Immunological techniques**	**SEC-2**	**2**	**2**
BS 303	English	CC-1C	3	3
BS 304	Second language	CC-2C	3	3
BS 305	**Optional I- Molecular Biology and Recombinant DNA Technology**	**DSC-1C**	**4T+3P=7**	**4+1=5**
BS 306	Optional II	DSC-2C	---------	4+1=5
BS 307	Optional III	DSC-3C	----------	4+1=5
	TOTAL			**25**
	SECOND YEAR- SEMESTER IV			
BS 401	**SEC 3: Molecular markers in plant breeding**	**SEC-3**	**2**	**2**
BS 402	**SEC 4: Drug designing**	**SEC-4**	**2**	**2**
BS 403	English	CC-1D	3	3
BS 404	Second language	CC-2D	3	3
BS 405	**Optional I- Bioinformatics and Biostatistics**	**DSC-1D**	**4T+3P=7**	**4+1=5**
BS 406	Optional II	DSC-2D	--------	4+1=5
BS 407	Optional III	DSC-3D	---------	4+1=5
	TOTAL			**25**

HEAD
Department of Genetics
Osmania University, Hyd-7.

THIRD YEAR- SEMESTER V				
CODE	COURSE TITLE	COURSE TYPE	HPW	CREDITS
BS 501	English	CC-1E	3	3
BS 502	Second language	CC-2E	3	3
BS 503	**Basics in Biotechnology**	**GE**	**4**	**4**
BS 504	**Optional I- A/B** **(A) Plant Biotechnology** **or** **(B) Medical Biotechnology**	**DSE -1E**	**4T+3P=7**	**4+1=5**
BS 505	Optional- II **A/B**	DSE -2E	------	4+1=5
BS 506	Optional- III **A/B**	DSE -3E	-------	4+1=5
	TOTAL			**25**
THIRD YEAR- SEMESTER VI				
BS 601	**Project in Biotechnology/** **Optional I: (IPR, Biosafety and Entrepreneurship)**	**Project work/Opt.P**		**4**
BS 602	English	CC-1F	3	3
BS 603	Second language	CC-2F	3	3
BS 604	**Optional II- A/B** **(A) Animal Biotechnology** **or** **(B) Environmental Biotechnology**	**DSE-1F**	**4T+3P=7**	**4+1=5**
BS 605	Optional- II A/B	DSE -2F	--------	4+1=5
BS 606	Optional- III A/B	DSE -3F	-------	4+1=5
	TOTAL			**25**
	TOTAL Credits			**150**

Total credits= 164-12 (AECC 4 + SEC 8) =15

AECC: Ability Enhancement Compulsory Course
SEC: Skill Enhancement Course
DSC: Discipline Specific Course
DSE: Discipline Specific Elective
GE: Generic Elective

HEAD
Department of Genetics
Osmania University, Hyd-7.

B.Sc BIOTECHNOLOGY I YEAR
SEMESTER- I
Optional I (DSC-1A)
BS 104: CELL BIOLOGY AND GENETICS

1. **Unit : Cell structure and Functions**
   - 1.1. Cell as basic unit of living organisms-bacterial, fungal, plant and animal cells
   - 1.2. Ultrastructure of prokaryotic cell (cell membrane and plasmids, Nucleoid)
   - 1.3. Ultrastructure of eukaryotic cell (cell wall, cell membrane, nucleus, mitochondria, chloroplast, endoplasmic reticulum, Golgi apparatus, vacuoles)
   - 1.4. Fluid mosaic model, Sandwich model, Cell membrane permeability
   - 1.5. Structure of chromosome-morphology, components of chromosomes (histones and non- histones), specialized chromosomes (Polytene, Lampbrush)
   - 1.6. Chromosomal aberrations- structural and numerical

2. **Unit: Cell Division and Cell cycle**
   - 2.1. Bacterial cell division
   - 2.2. Eukaryotic cell cycle - phases
   - 2.3. Mitosis - Stages (spindle assembly) - significance
   - 2.4. Meiosis- Stages (synaptonemal complex) - significance
   - 2.5. Senescence and necrosis
   - 2.6. Apoptosis

3. **Unit: Principles and mechanism of inheritance**
   - 3.1. Mendel's experiments - factors contributing to success of Mendel's experiments
   - 3.2. Law of segregation - Monohybrid Ratio; Law of independent assortment- Dihybrid ratio, Trihybrid ratio
   - 3.3. Deviation from Mendel's laws- partial or incomplete dominance (eg: Flower Color in Mirabilis jalapa), Co-dominance (eg: MN Blood groups), Non allelic interactions - types of epistasis, modification of dihybrid ratios
   - 3.4. Penetrance and Expressivity (eg: Polydactyly, Waardenburg syndrome), pleiotropism, phenocopy- microcephaly, cleft lip.
   - 3.5. Multiple alleles (eg: Coat color in Rabbits, eye color in Drosophila and ABO Blood groups)
   - 3.6. X-Y chromosomes - Sex determination in Drosophila, Man, X-linked inheritance - Hemophilia and Color blindness; X-inactivation.

4. **Unit: Linkage, Recombination and Extension to Mendel's Laws**
   - 4.1. Linkage and recombination - Cytological proof of crossing over, phases of linkage, recombination frequency, gene mapping and map distance
   - 4.2. Non-Mendelian Inheritance - Maternal effect (Shell coiling in snail), variegation in leaves of Mirabilis jalapa
   - 4.3. Cytoplasmic male sterility in Maize.
   - 4.4. Mitochondrial inheritance in human and poky in Neurospora crassa
   - 4.5. Chloroplast inheritance in Chlamydomonas
   - 4.6. Hardy-Weinberg Equilibrium.

HEAD
Department of Genetics
Osmania University, Hyd-7.

OPTIONAL I: PRACTICALS
CELL BIOLOGY AND GENETICS

1. Microscopic observation of cells: bacteria, fungi, plant and animal
2. Preparation of different stages of Mitosis (onion root tips)
3. Preparation of different stages of Meiosis (grasshopper testis)
4. Preparation of Polytene chromosome from Drosophila salivary gland
5. Monohybrid and dihybrid ratio in Drosophila
6. Monohybrid and dihybrid ratio in Maize
7. Problems on co-dominance, epistasis, two point and three point test cross, gene mapping.
8. Statistical applications of Hardy-Weinberg Equilibrium

Spotters:

1. Prokaryotic Cell (Bacteria)
2. Mitochondria
3. Chlorolplast
4. Polytene Chromosomes
5. Test Cross
6. Blood Grouping
7. Hemophilia Pedigree
8. Crossing Over
9. Synaptonemal Complex
10. Nucleosome Model

REFERENCE BOOKS

1. Cell & Molecular Biology. E.D.D De Robertis & E.M.F De Robertis, Waverly publication
2. An introduction to Genetic Analysis by Anthony, J.F. J.A. Miller, D.T. Suzuki, R.C. Richard Lewontin, W.M-Gilbert, W.H. Freeman publication
3. Principles of Genetics by E.J.Gardner and D.P. Snusted. John Wiley & Sons, New York
4. The science of Genetics, by A.G. Atherly J.R. Girton, J.F. Mcdonald, Saundern College publication
5. Principles of Genetics by R.H. Tamarin McGrawhill
6. Theory & problems in Genetics by Stansfield, Schaum out line series McGrawhill
7. Molecular Cell Biology Lodish, H., Baltimore, D; fesk, A., Zipursky S.L., Matsudaride, P. and Darnel. American Scientific Books. W.H. Freeman, New York
8. The cell: A molecular approach. Geoffrey M Cooper, Robert E Hausman, ASM press
9. Cell and Molecular Biology, Concepts and Experiments – Gerald Karp, John Wiley & Sons, Inc.
10. Cell Biology And Genetics by P.K. GUPTA

HEAD
Department of Genetics
Osmania University, Hyd-7

B.Sc BIOTECHNOLOGY I YEAR
SEMESTER- II
OPTIONAL I (DSC-1B)
BS 204: BIOLOGICAL CHEMISTRY AND MICROBIOLOGY

1. **Unit: Biomolecules**
   - 1.1. Carbohydrates - importance, classification; structure and functions of monosaccharides (glucose & fructose), disaccharides (sucrose, lactose & maltose) and polysachharides (starch, glycogen & insulin)
   - 1.2. Amino acids - importance, classification, structure, physical and chemical properties of amino acids; peptide bond formation
   - 1.3. Proteins - importance, structure of proteins- primary, secondary, tertiary and quaternary
   - 1.4. Lipids - importance, classification- simple lipids (triacylglycerides & waxes), complex lipids (phospholipids & glycolipids), derived lipids (steroids, terpenes & carotenoids)
   - 1.5. Nucleic acids: structure and chemistry of DNA (Watson and crick) and RNA(TMV) structure and forms of DNA (A, B and Z)
   - 1.6. Enzymes - importance, classification and nomenclature; Michaelis-Menton Equation, factors influencing the enzyme reactions; enzyme inhibition (competitive, uncompetitive & mixed), co-enzymes

2. **Unit: Bioenergetics**
   - 2.1. Glycolysis, Tricarboxylic Acid (TCA) Cycle
   - 2.2. Electron Transport, Oxidative Phosphorylation
   - 2.3. Gluconeogenesis and its significance
   - 2.4. Transamination and Oxidative deamination reactions of amino acids
   - 2.5. β-Oxidation of Fatty acids
   - 2.6. Glyoxalate cycle.

3. **Unit: Fundamentals of Microbiology**
   - 3.1. Historical development of microbiology and contributors of microbiology
   - 3.2. Microscopy: Bright field microscopy, Dark field microscopy, Phase contrast microscopy, Fluorescent microscopy, Scanning and Transmission electron microscopy
   - 3.3. Outlines of classification of microorganisms
   - 3.4. Structure and general characteristics of bacteria and virus
   - 3.5. Disease causing pathogens and symptoms (eg: *Mycobacterium*, *Hepatitis*)
   - 3.6. Structure and general characteristics of micro-algae and fungi

4. **Unit: Culture and identification of microorganisms**
   - 4.1. Methods of sterilization - physical and chemical methods
   - 4.2. Bacterial nutrition - nutritional types of bacteria, essential macro, micro nutrients and growth factors.
   - 4.3. Bacterial growth curve - batch and continuous cultures, synchronous cultures measurement of bacterial growth-measurement of cell number and cell mass
   - 4.4. Factors affecting bacterial growth
   - 4.5. Culturing of anaerobic bacteria and viruses
   - 4.6. Pure culture and its characteristics

HEAD
Department of Genetics
Osmania University, Hyd-7.

OPTIONAL I: PRACTICALS

BIOLOGICAL CHEMISTRY AND MICROBIOLOGY

1. Preparation of normal, molar& molal solutions.
2. Preparation of buffers (acidic, basic& neutral)
3. Qualitative tests of sugars, amino acids& lipids
4. Estimation of total sugars by anthrone method
5. Separation of amino acids by paper chromatography
6. Estimation of proteins by biuret method
7. Sterilization methods
8. Preparation of microbiological media (bacterial, algal & fungal)
9. Isolation of bacteria by streak, spread and pour plate methods
10. Isolation of bacteria from soil
11. Simple staining and differential staining (gram's staining)
12. Bacterial growth curve
13. Technique of micrometry (ocular and stage)

Spotters:

1. Osazone
2. Globular protein
3. Lock and key model
4. Completive inhibition
5. RUBISCO
6. ATP synthase
7. Autoclave
8. Laminar air flow
9. Tyndalization
10. Bacterial growth curve
11. Hot air oven
12. Serial dilution technique

REFERENCE BOOKS

1. Lehninger Principles of Biochemistry By: David L. Nelson and Cox
2. Biochemistry By: Rex Montgomery
3. Harper's Biochemistry By: Robert K. Murray
4. Enzymes By: Trevor Palmer
5. Enzyme structure and mechanism By: AlanFersht
6. Principles of Biochemistry By: Donald J. Voet, Judith G.Voet, Charlotte W.Pratt
7. Analytical Biochemistry By: Cooper
8. Principles and techniques of Biochemistry and Molecular Biology Edited By: Keith Wilson and John Walker
9. Practical Biochemistry By: Plummer
10. Biology of Microorganisms by: Brock, T.D. and Madigan, M.T.
11. Microbiology by: Prescott, L.M., Harley, J.P. Klein,D.A.
12. Microbiology by: Pelczar, M.J, Chan, E.C.S., Ereig, N.R.
13. Microbiological applications by: Benson

HEAD
Department of Genetics
Osmania University, Hyd-7.

B.Sc BIOTECHNOLOGY II YEAR
SEMESTER- III
SKILL ENHANCEMENT COURSE-1 (SEC-1)
BS 301: INDUSTRIAL FERMENTATIONS

1. Unit: Production of industrial chemicals, biochemicals and chemotherapeutic products.

1.1. Propionic acid, butyric acid, 2-3 butanediol, gluconic acid, itaconic acid
1.2. Biofuels: biogas, ethanol, butanol, hydrogen, biodiesel
1.3. Microbial electricity
1.4. Starch conversion processes; microbial polysaccharides
1.5. Microbial insecticides; microbial flavours and fragrances, newer antibiotics
1.6. Anti cancer agents, amino acids.

2. Unit: Microbial products of pharmacological interest

2.1. Steriod fermentations and transformations
2.2. Over production of microbial metabolite, secondary metabolism - its significance and products
2.3. Metabolic engineering of secondary metabolism for highest productivity
2.4. Enzyme and cell immobilization techniques in industrial processing
2.5. Enzymes in organic synthesis, proteolytic enzymes, hydrolytic enzymes, glucose isomerise
2.6. Enzymes in food technology/organic synthesis

3. Unit: Purification and characterization of proteins

3.1. Upstream and downstream processing, solids and liquid handling.
3.2. Distribution of microbial cells, centrifugation, filtration of fermentation broth
3.3. Ultra centrifugation
3.4. Liquid extraction
3.5. Ion-exchange recovery of biological products.
3.6. Experimental model for design of fermentation systems; anaerobic fermentations.

4. Unit: Rate equations for enzyme kinetics

4.1. Simple and complex reactions.
4.2. Inhibition kinetics; effect of pH and temperature on rate of enzyme reactions.
4.3. Mathematical derivation of growth kinetics
4.4. Mathematical derivations of batch and continuous culture operations; single stage CSTR; mass transfer in aerobic fermentation; resistances encountered; overall mass transfer co-efficient (Ka) determination
4.5. Factors depending on scale up principle and different methods of scaling up.
4.6. Metabolic engineering of antibiotic biosynthetic pathways.

B.Sc BIOTECHNOLOGY II YEAR
SEMESTER- III
SKILL ENHANCEMENT COURSE -2 (SEC- 2)
BS 302: IMMUNOLOGICAL TECHNIQUES

1. Unit: Antibody assays - Principle, Methodology and Applications

1.1. Antigen - Antibody reactions: opsonisation, neutralization, precipitation & agglutination
1.2. Immuno diffusion & radial diffusion
1.3. Immunoelectrophoresis - rocket and counter current
1.4. ELISA & western blotting
1.5. Radioimmunology assay & immunofluorescent assay
1.6. Immunohistochemistry

2. Unit: Cellular Assays - Principle, Methodology and Applications

2.1. Total and differential count in human peripheral blood
2.2. Separation of mononuclear cells from human peripheral blood
2.3. Cell viability assay using tryphan blue
2.4. Lymphocyte transformation assay
2.5. Enumeration of T & B cells from human peripheral blood
2.6. Micro cytotoxicity assay for HLA typing

REFERENCE BOOKS

1. Essential Immunology by I. Roitt, Publ: Blackwell
2. Immunology by G. Reever& I. Todd, Publ: Blackwell
3. Cellular and Molecular Immunology by Abbas AK, Lichtman AH, Pillai S. Saunders publication, Philadelphia
4. Kuby's Immunology by Golds RA, Kindt TJ, Osborne BA. W.H. Freeman and company, New York

HEAD
Department of Genetics
Osmania University, Hyd-7.

B.Sc BIOTECHNOLOGY II YEAR
SEMESTER- III
OPTIONAL-I (DSC-1C)
BS 305: MOLECULAR BIOLOGY AND RECOMBINANT DNA TECHNOLOGY

1. Unit: Genome organization and DNA replication

1.1. DNA as the genetic material - Griffiths transformation experiment, Avery, MacLeod and McCarty's experiments and Hershey & Chase phage-labelling experiment; RNA as genetic material-Tobacco mosaic virus
1.2. Organization of prokaryotic genome and eukaryotic nuclear genome
1.3. Organization of Mitochondrial and chloroplast genomes
1.4. DNA Replication - enzymes involved in the replication of DNA, origin of replication fork
1.5. Replication of prokaryotic genome and nuclear genome of eukaryotes
1.6. Mutations - types of mutations; spontaneous mutations and induced mutations

2. Unit: Gene expression in prokaryotes and eukaryotes

2.1. Structure of prokaryotic gene; structure of eukaryotic gene; structure and functions of prokaryotic RNA polymerase-subunits
2.2. Transcriptional machinery in eukaryotes (RNA polymerases) and their structural and functional features
2.3. Genetic code - properties, deciphering of genetic code, wobble hypothesis
2.4. Transcription mechanism in prokarytotes - initiation, elongation & proof reading, termination (rho independent& rho dependent)
2.5. Transcription in eukaryotes - Initiation, elongation & termination factors
2.6. Translation mechanism - initiation, elongation and termination

3. Unit: Gene regulation in prokaryotes and eukaryotes

3.1. Prokaryotic transcriptional regulation (inducible system) - operon concept; lac operon & glucose effect
3.2. Prokaryotic transcriptional regulation (repressible system) - tryptophan operon
3.3. Post-transcriptional modifications - capping, poly- adenylation
3.4. Splicing and alternate splicing
3.5. Post-translational modifications - glycosylation, acetylation, and ubiquitination
3.6. Gal regulation in yeast - mating type gene switching

4. Unit: Recombinant DNA technology

4.1. Enzymes used in molecular cloning: restriction endonuclease, DNA ligases, polynucleotide kinase, klenow enzyme and DNA polymerase
4.2. Cloning Vectors: PBR 322, bacteriophage, cosmid, phagemid, shuttle vectors
4.3. Vectors for library preparation (lambda phage vectors, cosmids, BAC & YAC)
4.4. Gene transfer techniques: physical, chemical and biological methods
4.5. Selection of recombinant clones - colony hybridization & library screening
4.6. Applications of recombinant DNA technologies - agriculture, diagnostics, industrial, pharmaceutics and medicine

HEAD
Department of Genetics
Osmania University, Hyd-7.

OPTIONAL-I: PRACTICALS
MOLECULAR BIOLOGY AND RECOMBINANT DNA TECHNOLOGY

1. Isolation of DNA from bacterial cells
2. Isolation of plasmid DNA
3. Agarose gel electrophoresis of DNA
4. Quantification of DNA by Spectrophotometer
5. Separation of proteins by SDS-PAGE
6. Polymerase Chain Reaction
7. Restriction digestion of DNA
8. Bacterial transformation

Spotters:

1. PCR
2. RNA polymerase
3. Okazaki fragments
4. Plasmid vector map
5. Prokaryotic gene
6. Eukaryotic gene
7. Splicing
8. Post transcriptional modifications
9. Point mutations
10. Lac operon
11. Tryptophan operon
12. Post translational modifications (PTMS)

REFERENCE BOOKS

1. Molecular Biology of the cell by Alberts, B; Bray, D, Lews, J., Raff, M., Roberts, K and Watson, J.D. Garland publishers, Oxford
2. Molecular Biology of the Gene by Watson, Hopkins, Goberts, Steitz and Weiner (Pearson Education)
3. Text Book of Biotechnology by H.K. Das (Wiley Publications)
4. Gene Structure & Expression by J.D. Howkins, Publ: Cambridge
5. Test Book of Molecular Biology by K.S. Sastry, G. Padmanabhan& C. Subramanyan, Publ: Macmillan India
6. Principles of Gene Manipulation by R.W. Old & S.B. Primrose, Publ: Blackwell
7. Genes by B. Lewin - Oxford Univ. Press
8. Molecular Biology & Biotechnol. by H.D. Kumar, Publ: Vikas
9. Methods for General & Molecular Bacteriology by P. Gerhardf et al., Publ: ASM
10. Molecular Biotechnology by G.R. Click and J.J. Pasternak, Publ: Panima
11. Genes and Genomes by Maxine Singer and Paul Berg
12. Molecular Biology by D. Freifelder, Publ: Narosa
13. Molecular biology by F. Weaver. WCB/McGraw Hill.
14. Gene, Genomics and Genetic Engineering by Irfan Ali Khan and AtiyaKhanum (Ukaaz Publications).

HEAD
Department of Genetics
Osmania University, Hyd-7.

B.Sc BIOTECHNOLOGY II YEAR
SEMESTER- IV
SKILL ENHANCEMENT COURSE-3 (SEC-3)
BS 401: MOLECULAR MARKERS IN PLANT BREEDING

1. Unit: Molecular markers in Plant Breeding

1.1. Types of markers - morphological, cytological, biochemical and genetic markers
1.2. Development of molecular markers - scope in plant breeding; criteria for ideal molecular markers
1.3. Types of molecular markers
1.4. Hybridization based molecular markers - RFLP
1.5. PCR based molecular markers - RAPD, SSRs, AFLP
1.6. Sequence based molecular markers - SNPs and DArTs

2. Unit: Applications of Molecular markers in Plant Breeding

1.1. Segregating populations - backcross, double haploid, F_2&F_3 families, RILs
1.2. Linkage mapping and QTL mapping
1.3. Marker Assisted Selection (MAS) - procedure and applications
1.4. Map based cloning of genes
1.5. Fingerprinting - fingerprinting genotypes; assessment of genetic similarity among genotypes; conservation, evaluation and use genetic resources
1.6. Hybrid testing

REFERENCE BOOKS

1. Gupta PK. 2010. Plant Biotechnology. Rastogi Publications.
2. Chawla HS. 2011. Introduction to Plant Biotechnology. Oxford and IBH Publishing Co. Pvt Ltd.
3. Chittaranjan K. 2006-07. Genome Mapping and Molecular Breeding in Plants. Vols. I-VII. Springer.16
4. Newbury HJ. 2003. Plant Molecular Breeding. Blackwell Publ.Weising K, Nybom H, Wolff K & Kahl G. 2005. DNA Fingerprinting in Plants: Principles, Methods and Applications. Taylor & Francis.

HEAD
Department of Genetics
Osmania University, Hyd-7.

B.Sc BIOTECHNOLOGY II YEAR
SEMESTER- IV
SKILL ENHANCEMENT COURSE-4 (SEC-4)
BS 402: DRUG DESIGNING

1. Unit: Introduction to Drug Discovery

1.1. Drug discovery process - historical perspective and challenges
1.2. Drug targets: proteins- receptors, ion channels and transporters; DNA- gene specific inhibitors of transcription
1.3. Drug target identification and validation: genetic approaches to identify target candidates such as mapping disease loci; role of bioinformatics in the analysis of nucleic acid sequence, protein sequence and structure.
1.4. Structural bioinformatics: prediction of 3D structure of protein using homology modelling, threading and ab-initio approach.
1.5. Structure-based drug design: active site detection, docking, binding energy calculations
1.6. Ligand-based drug design: computational methods to screen databases for new leads

2. Unit: Strategies of Drug Development

2.1. Strategies of drug designing: lead generation through combinatorial chemistry
2.2. Preparation of active compounds: natural products, synthetic compounds, semi synthetic compounds
2.3. Lead identification: High throughput screening and hit generation - small molecule drugs, large molecule drugs.
2.4. Lead optimization: Properties of druggable compounds (Lipinski rule), pharmacokinetics and pharmacodynamics
2.5. Screening of lead molecules from the phase I- IV to final drug molecule.
2.6. Pharmacogenomics: it's role in drug development and optimization

REFERENCE BOOKS

1. Textbook of Drug Design. Krogsgaard-Larsen, Liljefors and Madsen (Editors), Taylor and Francis, London UK, 2002.
2. Drug Discovery Handbook S.C. Gad (Editor) Wiley-Interscience Hoboken USA, 2005.
3. Advanced Computer- Assisted Techniques in Drug Discovery in Methods and Principles in Medicinal Chemistry by Han van de Waterbeemd (ed.) Volume 3,1994, Publishers, New York, NY (USA).
4. Virtual Screening for Bioactive Molecules by in Methods and Principles in Medicinal Chemistry, Edited by Hans-Joachim Bohm and Gisbert Schneider,Volume 10, 2000
5. Burger's Medicinal Chemistry and Drug Discovery, 6th Edition, Vol. 1. Principles and Practice, edited by M. E. Wolff, John Wiley & Sons: New York, 2003.
6. Real world drug discovery: A chemist's guide to biotech and pharmaceutical research by Robert M. Rydzewski, Elsevier Science, 1 edition (2008)
7. Drug discovery and development: Technology in transition by Raymond G Hill, Churchill Livingstone, 2 edition (2012)

HEAD
Department of Genetics
Osmania University, Hyd-7.

B.Sc BIOTECHNOLOGY II YEAR
SEMESTER- IV
OPTIONAL-I (DSC-1D)
BS 405: BIOINFORMATICS AND BIOSTATISTICS

1. Unit: Introduction to bioinformatics and biological databases

1.1. Bioinformatics definition, history, scope and applications
1.2. Bioinformatics tools and resources- internet basics, role of internet, free online tools, downloadable free tools
1.3. Bioinformatic web portals – NCBI, EBI, ExPASy
1.4. Biological databases: Classification of databases - primary (Genbank), secondary (PIR) and tertiary or composite (KEGG) databases
1.5. Sequence databases - DNA sequence databases (ENA & DDBJ)
1.6. Protein sequence databases (Swissprot & PROSITE)

2. Unit: Sequence Alignment

2.1. Basics of sequence alignment - match, mismatch, gaps, gap penalties, scoring alignment
2.2. Types of sequence alignment - pairwise and multiple alignment, local and global alignment
2.3. Dot matrix comparison of sequences
2.4. Scoring matrices - PAM and BLOSUM
2.5. Pairwise sequence similarity search by BLAST and FASTA
2.6. Concepts of phylogeny - distance based (NJ method) and character based (ML method) tree construction methods

3. Unit: Descriptive Biostatistics and Probability

3.1. Introduction to biostatistics, kinds of data and variables - based on nature (numerical- discrete and continuous; categorical- ordinal and nominal) - based on source (primary and secondary data); sample size, sampling methods and sampling errors.
3.2. Data tabulation and representation methods: graphical methods- stem and leaf plot, line diagram, bar graphs, histogram, frequency polygon, frequency curves; diagrammatic method- pie diagram
3.3. Measures of central tendency – mean, median, mode; merits and demerits
3.4. Measures of dispersion- range, variance, standard deviation, standard error and coefficient of variation; merits and demerits
3.5. Concepts of probability - random experiment, events, probability of an event, probability rules (addition and multiplication), uses of permutations and combinations, random variables (discrete and continuous)
3.6. Probability distributions: Binomial & Poisson distributions for discrete variables, Normal distribution for continuous variables

4. Unit: Applications of Biostatistics

4.1. Hypothesis testing - steps in testing for statistical hypothesis, null and alternative hypothesis, level of significance- type-1 and type-2 errors
4.2. Test of significance for small samples - Student's t-test (one sample and two samples)
4.3. Test of significance for large samples - Z-test for means and proportions
4.4. Chi-square test and its applications - goodness of fit, test of independence
4.5. Analysis of Variance (ANOVA) - one way analysis
4.6. Correlation - definition, simple and linear analysis, Karl Pearson's correlation coefficient

OPTIONAL I: PRACTICALS
BIOINFORMATICS AND BIOSTATISTICS

1. Exploring web portals - NCBI, EBI & ExPASy
2. Literature search through Pubmed and Pubmed Central
3. Sequence retrieval from Genbank, ENA, Swissprot
4. Pairwise homology search by BLAST and FASTA
5. Calculation of mean, median, mode, standard deviation, variance, standard error and coefficient of variation
6. Construction of bar diagram, pie diagram, line diagram, histogram
7. Problems on hypothesis testing using Z- test, t-test and Chi-square test
8. Problems on probability and probability distributions

Spotters

1. Line diagram, bar diagram & pie diagrams
2. Histogram, frequency polygon & frequency curve
3. Normal Probable curve
4. GenBank
5. DDBJ
6. SWISS-PROT
7. PROSITE
8. PIR
9. BLAST
10. Pairwise alignment
11. Multiple sequence alignment
12. PAM and BLOSUM
13. Phylogenetic tree

RECOMMENDED BOOKS

1. Khan &Khanum (2004), Fundamentals of Biostatistics, II Revised Edition, Ukaaz Publication
2. Bailey, N.T.J , Statistical methods in Biology, Cambridge Univ. Press
3. Fundamentals of Biostatistics, P HanmanthRao and K.Janardhan
4. Danial, W. W, Biostatistics, Wiley
5. Introduction to Bioinformatics by Aurther M lesk
6. Developing Bioinformatics Computer Skills by: Cynthia Gibas, Per Jambeck
7. Bioinformatics second edition by David M mount
8. Essential Bioinformatics by Jin Xiong
9. Bioinformatics Computing by Bryan Bergeron
10. Bioinformatics: Concepts, Skills & Applications by R.S. Rastogi
11. Queen, J. P., Quinn, G. P., &Keough, M. J. (2002). *Experimental design and data analysis for biologists.*Cambridge University Press
12. Mahajan, B.K. (2002). Methods in biostatistics. Jaypee Brothers Publishers

HEAD
Department of Genetics
Osmania University, Hyd-7.

B.Sc BIOTECHNOLOGY III YEAR
SEMESTER- V
GENERIC ELECTIVE (GE)
BS 503: BASICS IN BIOTECHNOLOGY

1. Unit: Agricultural Biotechnology

1.1. Plant tissue culture - media, sterilization, culture types
1.2. Micro-propagation, Synthetic seeds, Somatic hybrids and haploid plants
1.3. Transgenic plants - direct & indirect methods of gene transfer
1.4. Applications of transgenic plants - improving productivity & nutritional quality
1.5. Applications of transgenic plants - stress tolerant plants & molecular farming
1.6. Biofertilizers and biopesticides

2. Unit: Microbial and Industrial Biotechnology

2.1. Exploitation of micro-organisms and their products
2.2. Isolation, screening and selection of microorganisms for industrial products
2.3. Preservation of microorganisms
2.4. Strain development and improvement, strategies of strain improvement selection and recombination
2.5. Production of recombinant DNA vaccine, amino acids, vitamins
2.6. Single cell protein, dairy products, penicillin and streptomycin production

3. Unit: Animal and Medical Biotechnology

3.1. Cell culture technique and its applications
3.2. Animal breeding (selective breeding and cross breeding) and its limitations
3.3. *In vitro* techniques in animal improvement: *in vitro* fertilization & microinjection
3.4. Genetically modified animals: transgenic & knock-outs
3.5. Mouse models of disease: cancer and diabetes
3.6. Biotechniques: gel electrophoresis and PCR

4. Unit: Computer applications in Biotechnology

4.1. Scope of computer applications in Biotechnology
4.2. Biotechnology tools and resources - role of the internet, free online tools, downloadable free software
4.3. Biotechnology web portals – NCBI, EBI, ExPASy
4.4. Biological databases: classification of databases - the primary (Genbank), secondary (PIR) databases
4.5. Sequence databases - DNA sequence databases (ENA &DDBJ)
4.6. Protein sequence databases (Swissprot & PROSITE)

B.Sc BIOTECHNOLOGY III YEAR
SEMESTER- V
OPTIONAL- I (A) (DSE- 1E)
BS 504(A): PLANT BIOTECHNOLOGY

1. Unit: Fundamentals of Plant Tissue Culture

1.1. Introduction to Plant tissue culture, totipotency of plant cells (dedifferentiation, redifferentiation and regeneration)
1.2. Nutritional requirements for plant tissue culture: nutrient media - macronutrients and micronutrients, media additives (carbon source, vitamins, amino acids); types of media
1.3. Plant growth regulators - auxins, cytokinins and gibberllins
1.4. Preparation of media, sterilization, selection & surface sterilization of explant, inoculation, incubation and culture of plant tissue *in vitro*
1.5. Induction of callus cultures and cell suspension cultures
1.6. Organogenesis and somatic embryogenesis

2. Unit: Applications of Plant Tissue Culture

2.1. Meristem culture, micropropagation and their applications
2.2. Encapsulation and production of synthetics seeds and their applications
2.3. Cell suspension cultures (batch and continuous cultures) and applications
2.4. Protoplast isolation, culture and fusion - development of somatic hybrids & cybrids and their applications
2.5. Somaclonal variation and its applications
2.6. Anther and pollen culture for production of haploids & their applications
2.7. Cryopreservation - conservation of plant germplasm

3. Unit: Production of Transgenic Plants

3.1. Direct gene transfer techniques - physical methods: microinjection, particle bombardment (gene gun) and electroporation & chemical methods
3.2. Molecular mechanism of *Agrobacterium* infection and features of Ti Plasmid
3.3. *Agrobacterium* mediated gene transfer using binary and co-integrate vectors
3.4. Viral vectors for gene transfer into plants
3.5. Selection of transgenic plants using reporter and selection marker genes
3.6. Genome editing - CRISPR CAS 9 Technology

4. Unit: Applications of Transgenic Plants

4.1. Herbicide resistance in transgenic plants - glyphosate tolerance
4.2. Insect resistant transgenic plants: Bt cotton, proteinase inhibitors, lectins
4.3. Virus, bacterial and fungal resistant transgenic plants
4.4. Abiotic Stress tolerance: drought, heat and salinity stress tolerant plants
4.5. Transgenic plants with enhanced nutritional value: vitamin A, oil, amino acids
4.6. Transgenic plants as bioreactors: edible vaccines, antibody production, biodegradable plastics

OPTIONAL-I (A): PRACTICALS
PLANT BIOTECHNOLOGY

1. Preparation of media for plant tissue culture
2. Sterilization methods of explants (seed, leaf, inter node & root) and inoculation
3. Establishment of callus cultures – from carrot/rice
4. Preparation of synthetic seeds
5. Meristem culture
6. Cell suspension cultures
7. Protoplast isolation and culture
8. *Agrobacterium* mediated transformation

Spotters

1. Callus cultures
2. Sterilization techniques: autoclave and hot air Oven
3. Somatic embryos
4. Synthetic seeds
5. Meristem culture
6. Plant regeneration
7. Cell suspension cultures
8. Isolation of protoplasts
9. Particle bombardment (Gene gun)
10. Binary or co-integrate vectors
11. Gus gene expression in transgenic plant tissue
12. Golden Rice

REFERENCE BOOKS

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

HEAD
Department of Genetics
Osmania University, Hyd-7.

B.Sc BIOTECHNOLOGY III YEAR
SEMESTER- V
OPTIONAL- I (B) (DSE- 1E)
BS 504(B): MEDICAL BIOTECHNOLOGY

1. Unit: Inheritance of human diseases and karyotyping

1.1. Inheritance patterns - pedigree analysis of autosomal traits
1.2. Inheritance patterns - pedigree analysis of allosomal traits
1.3. Factors affecting pedigree pattern- penetrance, expressivity
1.4. Genetic heterogeneity - allele and locus heterogeneity
1.5. Karyotyping of human chromosomes
1.6. Chromosome staining - G, Q, R and C banding techniques

2. Unit: Genetic basis of human disorders

2.1. Chromosomal disorders caused due to structural chromosomal abnormalities (deletions, duplications, translocations and inversions)
2.2. Chromosomal disorders caused due to numerical chromosomal abnormalities (euploidy, aneuploidy, autosomal and allosomal)
2.3. Monogenic disorders (autosomal and X-linked diseases)
2.4. Mitochondrial diseases - LHON, MERRF
2.5. Multifactorial disorders - diabetes and hypertension
2.6. Cancer - types of cancer, genetic basis of cancer (oncogenes, tumour suppressor genes)

3. Unit: Techniques for diagnosis of human diseases

3.1. Prenatal diagnosis - invasive techniques - amniocentesis, chorionic villi sampling (Down's syndrome); non-invasive techniques - ultrasonography (neural tube defects)
3.2. Diagnosis using enzyme markers - Guthrie test (phenylketoneuria)
3.3. Diagnosis using monoclonal antibodies - ELISA (HIV)
3.4. DNA/RNA based diagnosis - HBV
3.5. PCR based genotyping techniques for diagnosis - RFLP (MTHFR C677T mutation)
3.6. Chip based diagnosis and applications - colon cancer

4. Unit: Therapeutic approaches for human diseases

4.1. Recombinant proteins - human growth hormone, insulin
4.2. Gene therapy - *ex vivo* and *in vivo* gene therapy
4.3. Stem cells - potency definitions; embryonic and adult stem cells
4.4. Applications of stem cell based therapies and regenerative medicine
4.5. DNA based vaccines, subunit vaccines - herpes simplex virus; recombinant attenuated vaccines - cholera vaccine
4.6. Applications of monoclonal antibodies

HEAD
Department of Genetics
Osmania University, Hyd-7.

OPTIONAL-I (B): PRACTICALS
MEDICAL BIOTECHNOLOGY

1. Karyotyping of normal human chromosome set
2. Karyotyping of autosomal abnormality (Down's syndrome)
3. Karyotyping of allosomal abnormality (Klinefelter syndrome)
4. Chromosome banding - G banding
5. Human pedigree analysis of autosomal disorder
6. Human pedigree analysis of allosomal disorder
7. Estimation of C-reactive protein
8. DOT ELISA

Spotters

1. Identify the karyotype (Down's syndrome)
2. Identify the karyotype (Klinefelter syndrome)
3. Chromosomal banding technique
4. Identify the inheritance pattern of pedigree (autosomal disorder)
5. Identify the inheritance pattern of pedigree (allosomal disorder)
6. Prenatal diagnosis - invasive technique
7. Prenatal diagnosis - non invasive technique
8. Identify the type of gene therapy - *ex vivo/in vivo*
9. Recombinant vaccine
10. ELISA technique
11. Identify the SNP genotypes of different samples after performing PCR-RFLP
12. Count the viable cells on neubauer chamber (hemocytometer)

REFERENCE BOOKS

1. Medical Biotechnology by Pratibha Nallari, V. Venugopalrao - Oxford Press
2. Introduction to Human Molecular Genetics by J.J Pasternak - John Wiley Publishers.
3. Human Molecular Genetics by Tom Strachen and A P Read - Bios Scientific Publishers
4. Human Genetics Molecular Evolution by McConkey
5. Recombinant DNA Technology by AEH Emery
6. Principles and Practice of Medical Genetics - I, II, III Volumes by AEH Emery
7. Molecular Biotechnology by Glick and Pasternak

HEAD
Department of Genetics
Osmania University, Hyd-7.

B.Sc BIOTECHNOLOGY III YEAR
SEMESTER- VI
OPTIONAL PAPER I
BS 601: IPR, BIOSAFETY AND ENTREPRENEURSHIP

1. Unit: Intellectual Property rights

1.1. Intellectual Property - meaning, nature
1.2. Significance and need of protection of intellectual property
1.3. Types of intellectual property rights: patent, trademarks, copyright, design registration, trade secret, geographical indicators, plant variety protection
1.4. Copyright: meaning, nature, historical evolution and significance
1.5. Ownership of copyright - rights of authors and owners, trademarks
1.6. Plant varieties protection and plant breeding rights

2. Unit: Patent laws

2.1. Patents - concept of patent- historical overview of the patent law in India
2.2. Kinds of patents - procedure for obtaining patent in India and in other countries
2.3. Patenting microbes and organisms- novelty, International Depository Authorities (IDAs), submitting details of the deposit
2.4. Patenting genes - pros and cons, ethics, examples
2.5. Patenting markers and variants - examples
2.6. Product vs process patent - product life cycle and process design.

3. Unit: Laboratory Management and Safety

3.1. Administration of laboratories, laboratory design, laboratory information management system
3.2. Laboratory safety - good laboratory practice (GLP), biosafety levels
3.3. Basic principles of quality control (QC) and quality assurance (QA)
3.4. Handling of hazardous compounds - chemicals, solvents, poisons, isotopes, explosives and biological strains
3.5. Storage of hazardous material
3.6. Disposal of biological and radioisotope wastes

4. Unit: Entrepreneurship

4.1. Concept, definition, structure and theories of entrepreneurship
4.2. Types of start-ups with examples
4.3. Types of entrepreneurship, environment, process of entrepreneurial development
4.4. Entrepreneurial culture, entrepreneurial leadership
4.5. Product planning and development - project management, search for business idea, concept of projects, project identification
4.6. Promoting bio-entrepreneurship

HEAD
Department of Genetics
Osmania University, Hyd-7.

B.Sc BIOTECHNOLOGY III YEAR
SEMESTER- VI
OPTIONAL- II (A) (DSE- 1F)
BS 604(A): ANIMAL BIOTECHNOLOGY

1. Unit: Animal cell culture: principles and applications

1.1. Cell culture technique: cell culture media, sterilization techniques
1.2. Characteristic features of cell lines and cell line maintenance
1.3. Methods of isolation and separation of various cell types and establishment of cell lines
1.4. Properties and types of stem cells, culturing of embryonic stem cells and adult stem cells
1.5. Manipulation of cells: electroporation, transfection, transduction and microinjection
1.6. Applications of cell culture: manufacturing, toxicity testing and tissue engineering

2. Unit: In vitro techniques in animal improvement

2.1. Principles of animal breeding: selective breeding, cross breeding and their limitations
2.2. Superovulation, collection of semen and ova
2.3. *In vitro* maturation of oocytes, artificial insemination
2.4. *In vitro* fertilization, embryo collection and embryo sexing
2.5. Somatic cell nuclear transfer, cloning of animals (example: Dolly)
2.6. Applications of in vitro techniques in animal improvement

3. Unit: Molecular markers in animal genetics

3.1. Developments in livestock genomics (Estimated Breeding Value -EBV)
3.2. Molecular markers: types and characteristics
3.3. RFLP and RAPD
3.4. SNPs and their application in genotyping
3.5. Identification and isolation of desired genes of interest
3.6. Marker-assisted selection

4. Unit: Genetically modified organisms

4.1. Animal models and their significance in scientific research
4.2. Mouse models for cancer
4.3. Generation of transgenic mouse
4.4. Generation of gene knock-out mouse
4.5. Genetically modified mice as disease models
4.6. Applications of genetically modified animals in understanding disease biology and drug development

HEAD
Department of Genetics
Osmania University, Hyd-7.

OPTIONAL-I (A): PRACTICALS
ANIMAL BIOTECHNOLOGY

1. Preparation of animal cell culture media
2. Sterilization of cell culture media
3. Cell counting by microscopy
4. Isolation of cells from chicken Liver
5. Establishment of primary cell culture: Liver/Spleen
6. Preparation of metaphase chromosomes
7. Culturing suspension cells
8. Culturing adherent cells

Spotters

1. Microscope
2. CO2 incubator
3. Biosafety cabinet/ Laminar air flow
4. Trypan blue stained cells
5. Cell culture flasks and dishes
6. Metaphase slide
7. Autoclave
8. Centrifuge
9. Example of an RFLP
10. Microinjection into egg cells

REFERENCE BOOKS

1. Text book of Animal Biotechnology by B Singh. The Energy and Resources Institute (teri)
2. Genetics for Animal Sciences by WH Freeman. Van Vleck LD, Pollak EJ & Bltenacu EAB. 1987.
3. Cancer Cell Culture: Methods and Protocols: 731 (Methods in Molecular Biology) Humana; 2nd ed. 2011 edition (28 April 2011)
4. Genetic Engineering by V.K.Agarwal and P.S. Varma, S. Chand & Company Ltd, 2009

HEAD
Department of Genetics
Osmania University, Hyd-7.

B.Sc BIOTECHNOLOGY III YEAR
SEMESTER- VI
OPTIONAL- II (B) (DSE- 1F)
BS 604(B): ENVIRONMENTAL BIOTECHNOLOGY

1. Unit: Environmental Pollution

1.1. Introduction to environment and pollution
1.2. Types of pollution - air, water and soil pollutions
1.3. Types of pollutants - inorganic, organic and biotic
1.4. Sources of pollution - domestic waste, agricultural waste, industrial effluents and municipal waste
1.5. Greenhouse gases, global warming and climate change
1.6. Measurement methods of environmental pollution - BOD & COD

2. Unit: Biomass and Biofuels

2.1. Renewable and non-renewable energy resources
2.2. Fossil fuels as energy source and their impact on environment
2.3. Biomass as source of energy (bioenergy)
2.4. Types of biomass - plant, animal and microbial biomass
2.5. Production of biofuels: bioethanol and biodiesel
2.6. Production of biohydrogen and biomethane

3. Unit: Biofertilizers and Biopesticides

3.1. Chemical fertilizers and their impact on environment (eutrophication)
3.2. Concepts of biofertilizers
3.3. Types of biofertilizers - bacterial, fungal and algal biofertilizers
3.4. Pesticides and their impact on environment
3.5. Concepts of biopesticides; types of biopesticides
3.6. Uses of biofertilizers & biopesticides

4. Unit: Bioremediation of Environmental Pollutants

4.1. Waste water treatment - sewage and industrial effluents (aerobic and anaerobic methods)
4.2. Bioremediation - concepts and types (*in-situ* and *ex-situ* bioremediation)
4.3. Bioremediation of toxic metal ions - biosorption and bioaccumulation
4.4. Composting of organic wastes
4.5. Microbial remediation of pesticides and xenobiotic compounds
4.6. Phytoremediation- concepts and applications

HEAD
Department of Genetics
Osmania University, Hyd-7.

OPTIONAL-I (B): PRACTICALS
ENVIRONMENTAL BIOTECHNOLOGY

1. Estimation of BOD in polluted water samples
2. Estimation of COD in polluted water samples
3. Estimation of total dissolved solid in waste water samples
4. Determination of quality of water sample (Coliform test)
5. Isolation of microorganisms from polluted soil/industrial effluents
6. Production of hydrogen or biogas
7. Identification and characterization of bioremediation microorganisms
8. Production of microbial biofertilizer

Spotters

1. Air/water/soil pollution
2. Municipal waste
3. Industrial effluents
4. Algal blooms
5. Green house effect
6. Plant biomass
7. Waste water treatment plant
8. Organic composting
9. Biogas plant
10. Xenobiotic degrading bacteria
11. Phytoremediation
12. Microbial biofertilizers

REFERENCE BOOKS

1. Text Book of Biotechnology by H.K. Das (Wiley Publications)
2. Biotechnology by H.J. Rehm and G. Reed. VIH Publications, Germany
3. Biogas Technology by b.T. Nijaguna
4. Biotechnology by K. Trehan
5. Industrial Microbiology by L.E. Casida
6. Food Microbiology by M.R. Adams and M.O. Moss
7. Introduction to Biotechnology by P.K. Gupta
8. Essentials of Biotechnòlogy for Students by Satya N. Das
9. Bioethics – Readings and Cases by B.A. Brody and H. T. Engelhardt. Jr. (Pearson Education)
10. Biotechnology, IPRs and Biodiversity by M.B. Rao and Manjula Guru (Pearson Education)

QUESTION PAPER PATTERN
FACULTY OF SCIENCE
B.SC. BIOTECHNOLOGY

Title of the Paper:
[Duration: 3 Hours] **[Max Marks=80M]**

SECTION-A

Short Answer type questions
Answer any EIGHT questions (TWO FROM EACH PART) [8x4=32M]

PART A:
1. Unit - I
2. Unit – I
3. Unit – I

PART B:
4. Unit – II
5. Unit - II
6. Unit – II

PART C:
7. Unit - III
8. Unit - III
9. Unit – III

PART D:
10. Unit - IV
11. Unit - IV
12. Unit – IV

SECTION-B

Essay Answer type question **[4x12=48M]**
Answer all questions

13. (a) Unit – I
OR
(b) Unit – I

14. (a) Unit –II
OR
(b) Unit -II

15. (a) Unit – III
OR
(b) Unit – III

16. (a) Unit- IV
OR
(b)Unit- IV