

BHARATHIAR UNIVERSITY, COIMBTORE:641 046

M.Sc. MICROBIOLOGY

SCHEME OF EXAMINATION (CBCS PATTERN)

(For the students admitted during the academic year 2015-2016 Batch onwards)

Study Components	Course Title	Ins. hrs / week	Exam				Credit
			Dur. Hrs.	CIA	Uni. exam	Total	
Semester I							
Paper I	Fundamentals of Microbiology and Bioinformatics	5	3	25	75	100	4
Paper II	Microbial Physiology and Biochemistry	5	3	25	75	100	4
Paper III	Applied Biotechniques	5	3	25	75	100	4
Paper IV	Environmental and Agricultural Microbiology	5	3	25	75	100	4
Practical	Practical I	5	-	-	-	-	-
Elective	Paper I	5	3	25	75	100	4
Semester II							
Paper V	Molecular Genetics	5	3	25	75	100	4
Paper VI	Virology and Nanotechnology	5	3	25	75	100	4
Paper VII	Bioprocess Technology	5	3	25	75	100	4
Paper VIII	Engineering of Genes and Proteins	5	3	25	75	100	4
Practical	Practical I	-	9	40	60	100	4
Practical	Practical II	5	9	40	60	100	4
Elective	Paper II	5	3	25	75	100	4
Semester III							
Paper IX	Immunology and Immunotechnology	5	3	25	75	100	4
Paper X	Medical Microbiology	5	3	25	75	100	4
Paper XI	Biotechnology and IPR	5	3	25	75	100	4
Paper XII	Microbial Food Technology	5	3	25	75	100	4
Paper XIII	Biostatistics and Research Methodology	5	3	25	75	100	4
Practical	Practical III	5	-	-	-	-	-
Semester IV							
Elective	Paper III	5	3	25	75	100	4
Practical	Practical III	5	9	40	60	100	4
Project	Project and viva voce	-	-	-	-	200*	8
Training	Industrial training and viva voce @	-	-	50	-	50*	2
Elective	Paper IV -Practical	5	9	40	60	100	4
Total						2250	90

* Project Report – 160 Marks, Viva voce- 40 Marks

* Students should undergo an institutional/industrial training relevant to any one of theory paper for a continuous period of 15 days before semester IV and submit report along with attendance certificate. Training Report – 40 Marks, Viva voce- 10 Marks.

@ No University Examinations. Only Continuous Internal Assessment (CIA).

List of Group Elective papers (Colleges can choose any one of the Group papers as electives)

	GROUP A	GROUP B	GROUP C
Paper I/Sem I	Principles of Quality Assurance	Environment and Health	Basic Biological Sciences
Paper II/Sem II	Quality Assessment in Pharmaceuticals	Communicable and Non-communicable diseases	Biophysics and Biochemistry
Paper III/Sem IV	Total Quality Management (TQM)	Health care of the community	Molecular Cytology and Tissue Engineering
Paper IV/Sem IV	Practical	Practical	Practical

Guidelines for the Project Work:

Two reviews to be conducted with all the students & staff members in the month of Jan. & Feb.
2nd review if necessary an external expert may be called.

SEMESTER I: PAPER I - FUNDAMENTALS OF MICROBIOLOGY & BIOINFORMATICS

UNIT I

History and Development: Spontaneous generation Conflict - Contributions of Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Edward Jenner, Iwanowski, Elie Metchnikoff, Beijerinck, Winogradsky, Paul Ehrlich, Beadle & Tatum, Griffith, Avery & McLeod, Lederberg & Zinder, Lwoff, Arber & Smith, Temin & Baltimore, Gilbert and Sanger, Montaigner and Galo, Kary Mullis.

UNIT II

Control of Microorganisms & Microscopy: Sterilization: Physical methods: Filtration, Heat : steam, flaming, incineration, Tyndallisation, dry heat – Radiation - ionising and non-ionising radiation. Chemical agents in sterilization: Phenolics, alcohol, halogens, heavy metals, quaternary ammonium compounds and aldehydes

Microscopy: Principle and working of Bright field, Dark field, Phase Contrast, Fluorescence, Con-focal scanning microscope and electron (TEM, SEM) microscopes.

Staining: Simple, Gram, Negative, Capsule, Spore staining, Flagellar, Nuclear staining, Acid fast and fungal staining.

UNIT III

Bacterial & Eukaryotic Microbial Taxonomy: Microbial evolution and diversity - Domains and kingdoms of life - Ultra structure of a bacterial cell. Bacterial Nomenclature – Classification of bacteria by physiological, metabolic, serological and molecular methods - Bergey's manual of systematic bacteriology with general characteristics of each division - Numerical taxonomy - 16S rRNA based classification. General characteristics and classification of algae. Structure and reproduction of *Chlamydomonas* sp. General characteristics and classification (Alexopolus) of fungi. Structure and reproduction of *Aspergillus niger* and *Saccharomyces cerevisiae*. General characteristics and classification of Protozoa. Structure and reproduction of *Paramecium* sp.

UNIT IV

Introduction to Bioinformatics, Data Bases and Sequence Alignment: Types of databases – DNA databases: GenBank, EMBL and DDBJ – cDNA databases: ESTs, STS, HTGS – NCBI: PubMed, Entrez, BLAST, OMIM – Protein databases: SWISSPROT, PIR – Secondary nucleotide sequence databases: UniGene - Composite Databases: NRDB, OWL – Sequence motif database: SMART and Pfam- Conserved domains database: PROSITE - Protein structure databases: PDB – ExPASy - Metabolic Pathway Database: KEGG. Sequence Homology - Similarity Search Tool: BLAST - Statistics of sequence alignment score: E value and P value – Multiple Sequence alignment – ClustalW and ClustalX.

UNIT V

Gene Finding, Structure Prediction and Phylogenetic Methods: Gene finding methods and GenScan -- Tertiary structure prediction methods- Phylogenetic Analysis: methods and interpretation of phylogenetic data - Molecular visualization tools: Swiss-PDB viewer, RasMol, QMol.

References

1. Atlas, R.M., 1997. Principles of Microbiology 2nd Ed. WCB McGraw Hill Publications, New Delhi.
2. Black, J.G., 1999. Microbiology: Principles and Explorations 4th Ed., Prentice Hall International, Inc.
3. Prescott, L.M., Harley, J.P. and Klein, D.A., 2005. Microbiology. 6th Ed., TATA Mc Graw Hill, New Delhi.
4. Alcamo E. 2001. Fundamentals of Microbiology. 6th Ed., Jones and Bartlett Publishers, New Delhi.
5. Salle A J. 2001. Fundamentals and Principles of Bacteriology. 7th Ed., Tata MC Graw Hill, New Delhi.
6. Madigan M.T, Martinko J M, Dunlap P V and Clark. D P. 2008. Brock Biology of Microorganisms. 12th Ed. Pearson/ Prentice Hall.
7. Lesk, A M.2002. Introduction to Bioinformatics. Indian Ed.. Oxford University Press.
8. Andreas D B. and Francis Outlette B F. 2001. Bioinformatics – a practical guide to the analysis of genes and proteins. 2nd Ed. Wiley Interscience, John wiley and Sons, Inc. Publication, New York.

PAPER II - MICROBIAL PHYSIOLOGY AND BIOCHEMISTRY

UNIT I

Microbial cell – Ultra structure of Prokaryotic and Eukaryotic cell. Sub cellular structures and cell envelope, Slime layer, Capsules, Cell wall, Pili, Flagella, Cell - inclusions, Endospores, Cell membrane – Liposomes – Uptake of nutrients by the cell – Facilitated diffusion – Active transport – Group translocation , Iron uptake. Pinocytosis and Phagocytosis.

UNIT II

Nutritional groups: Autotrophs – Photoautotrophs – Oxygenic and Anoxygenic. Photosynthesis – Assimilation of Co₂. Chemoautotrophs. Common nutrient requirements, Growth factors – Microbial growth – Growth curve – Measurement of microbial growth. Growth kinetics – Batch, Continuous and Synchronous cultures. Factors influencing the growth of microorganisms, Archaeobacteria – Adaptations to extreme environments

UNIT III

Carbohydrate metabolism – EMP, HMP and ED pathway – Kreb's Cycle – Glyoxylate cycle – Aerobic respiration – Substrate level and Oxidative phosphorylation – ATP generation. Lipid catabolism – β -oxidation. Anaerobic respiration – Sulphur compounds – Nitrate and Carbon -di -oxide as electron acceptors. Fermentation.

UNIT IV

Enzymes and co -enzymes: IUBMB classification and nomenclature of enzymes, active site, Lock and key Mechanism and induced fit hypothesis, Enzyme kinetics- negative and positive cooperatively, enzyme inhibition: Reversible – Competitive, Noncompetitive, uncompetitive, Irreversible inhibition.

UNIT V

Protein structures, Biosynthesis – Aminoacids: Aspartic and serine families. Fatty acid synthesis, Nucleotide biosynthesis- Bioluminescence.

References

1. Caldwell. D.R. 1995. Microbial Physiology and metabolism, Wm C. Brown Publishers.
2. Moat. A.G. and Foster. J.W. 1988. Microbial Physiology, John Wiley sons. White J.D. Motteshead. D.W. Harrison S.J. Environmental system 2^{ed}. 1992.
3. Stainier R.Y. Ingraham, J.L. Wheolis, H.H. and Painter. P,R. 1986. Microbiology.
4. David White, James Drummond, and Clay Fuqua. The Physiology and Biochemistry of Prokaryotes. 2011. Fourth Edition. Oxford University Press.
5. Principles of Biochemistry – Lehninger, Nelson, Cox, CBS publishers.
6. Gerhard Gottschalk. Bacterial Metabolism. Second edition. Springer.

PAPER III - APPLIED BIOTECHNIQUES

UNIT I

Fundamental building blocks – Atoms – Bonds and molecules. Macromolecules – Chemical nature and functions of Carbohydrate, Lipids, Proteins and Nucleic acids. Radioisotopes – Measurement, uses and safety aspects. Autoradiography, GM counter, Scintillation – Instrumentation and applications.

UNIT II

Colorimetry: Principles, Instrumentation and Applications– Beer Lambert's law and deviation – Analysis – Qualitative and Quantitative. Basic principles of spectrophotometry: The laws of absorption, principles and instrumentation for UV- visible and IR spectroscopy. Principles, theory and applications of spectrofluorometry, and Flame photometry, NMR, 3D structure by x- ray diffraction, ESR - Principles, Instrumentation and Applications. Analysis – Qualitative and Quantitative.

UNIT III

Centrifugation: Principles – Instrumentation – Types – Methods and Factors affecting sedimentation co-efficient - Applications.

UNIT IV

Chromatography: Principles, Instrumentation, Types and Detection methods – Paper, TLC, HPLC, GC, Ion-exchange, Column ,Gel permeation, Chiral, Hydroxyapatite, Immuno adsorption and Affinity Chromatography – Applications.

UNIT V

Electrophoresis – Principles, Instrumentation, Types. Staining and Detection methods – Isoelectrophoresis – isoelectric focusing – Applications.

References

1. Physical Biochemistry: David Freifelder.
2. Practical Biochemistry, Boyer.
3. Practical Biochemistry, Keith Wilson and John Walker, 4^{ed}. 1994.
4. Foundation in Microbiology, Kathleen Talaro and Arthur Talaro, WCB Publishers. 1993.

PAPER IV – ENVIRONMENTAL AND AGRICULTURAL MICROBIOLOGY

UNIT I

Aerobiology-Microbial contamination of air-Sources of contamination-Biological indicators of air pollution. Enumeration of bacteria from air, Air sampling devices. Significance of air Microflora, Outline of Airborne diseases (Bacterial - Whooping cough, Diphtheria, Pneumonia; Fungal - Aspergillosis, Cryptococcosis; Viral – Chickenpox, Influenza, Measles), Air sanitation. Effect of Air pollution on plants and Humans.

UNIT II

Soil Microbiology-Structure, Types, Physical and Chemical properties-Soil microbes (Types and Enumeration)-Weathering and Humus formation, Soil pollution-Sources. Biogeochemical cycling-Nitrogen, Carbon, Phosphorous, Sulphur, Iron cycles and its importance.

UNIT III

Aquatic Microbiology-Microbiology of water (Aquatic environment-Fresh and Marine)-Water Pollution and Waterborne Pathogens. Assessment of water quality (Chemical and Microbial) Bacteriological examination of water-Indicator organisms. Waste water treatment – BOD and COD.

UNIT IV

Microbial interaction-among microbes, with plants, Phyllosphere, Rhizosphere, Mycorrhizae-Symbiotic and free-living nitrogen fixers (*Rhizobium*, *Azotobacter*, *Azospirillum*, *Frankia*, *BGA* and *Azolla* -Phosphate solubilizers (*Phosphobacterium* and *Aspergillus*) - Phytopathogens-Bacterial, Fungal, Viral diseases (Wilt, Blight, Canker, Mosaic) - Control measures.

UNIT V

Recycling of Solid wastes-Composting-Biogas, Mushroom and SCP production from Waste. Biodegradation of Complex Polymers (Cellulose, Hemicellulose, Lignin, Chitin and Pectin), Bioremediation (In-situ, Ex-situ, Intrinsic, Engineered, Solid phase, Slurry phase, Mobilization and Immobilization systems) Bioaugmentation and Biostimulation, Bioleaching (Copper and Uranium) - Degradation of recalcitrant polymers and xenobiotics eg., cellulose, lignin and lignocellulose. GMOS and Environment. Applications of GIS and RS techniques in Environmental monitoring.

References

1. Brock Biology of microorganisms 12^{ed}, Madigan, Martinko, Dunlap, Clara, Pearson Intl. Ed
2. Mitchell. R. 1974. Introduction to environmental microbiology.
3. R. M. Atlas and R. Bartha - 1998 - Microbial Ecology - Fundamentals and Applications.
4. Campbell. R. 1983. Microbial Ecology, 2^{ed}.
4. Reiheimer. G. 1991. Aquatic Microbiology, 4^{ed}.
5. Dart. R.K. and Shettron R.J. 1980. Microbiological aspects of pollution control. 2^{ed}.
6. Martin Alexander, 1997. Introduction to Soil Microbiology.
7. Subbha Rao, M.S. 1995. Soil microorganisms and plant growth

M.Sc. MICROBIOLOGY
PRACTICAL I

1. Sterility control test
2. Media preparation – Liquid and Solid media, Agar deep, slant and plate.
3. Pure culture techniques – Streak plate, pour plate, spread plate, decimal dilution.
4. Micrometry – measurement of microorganisms.
5. Motility determination- Hanging drop and soft agar inoculation.
6. Enumeration of microorganisms from soil: Bacteria, Fungi and Actinomycetes.
7. Morphology of Mold, Yeast and Algae.
8. Staining: Smear fixation, simple, Gram, acid fast, spore, capsule and negative.
9. Growth curve: Direct microscopic (Haemocytometer, Viable count)
10. Effect of various intrinsic factors on the growth of bacterium and fungi – pH, Temperature, Osmotic pressure.
11. Anaerobic culture techniques; RCM, Mc Intosh Fildes anaerobic jar, Wright's tube method.
12. Phenol Co-efficient test.
13. IMViC test
14. Hydrogen sulphite test
15. Oxidase test
16. Calalase test
17. Urease test
18. Nitrate reduction test
19. Polymer degradation – Starch, Gelatin, Casein.
20. Carbohydrate fermentation.

SEMESTER II: PAPER V - MOLECULAR GENETICS

UNIT I

DNA and Replication: Mendelian principles – Discovery of DNA as genetic material - DNA structure & alternative forms of DNA. Organization of genetic material: Viruses and Bacteria-Eukaryotes: Nucleus and nucleosomes, Lamp brush chromosomes, Giant chromosomes - satellite DNA. DNA replication – prokaryotes and eukaryotes - theta and Plasmid DNA replication-rolling circle models of replication. Peptide Nucleic acid.

UNIT II

Transcription: Transcription in prokaryotes and eukaryotes – structures of rRNA, tRNA and mRNA, post transcriptional processes. Reverse Transcription. Antisense RNA and its significance.

UNIT III

Translation: Genetic code - Deciphering of genetic code and important properties of genetic code. Translation in prokaryotes and eukaryotes - post translational processing. Inhibitors of replication, transcription and translation.

UNIT IV

Genetic Recombination in Bacteria: Conjugation. F^+ v/s F^- , Hfr^+ v/s F^- , F' v/s F^- , Transformation, Transduction: generalized and specialized. Mobile elements in prokaryotes and eukaryotes – Insertion sequences, transposons - properties.

UNIT V

Gene Regulation , Mutagenesis and DNA Repair: Operon models - lactose, tryptophan and arabinose operon. Linkage and genetic maps. Genetics of T4 and λ phages – Genetic mapping of T4 phage. C-value paradox. Hardy Weinberg Equilibrium. Mutation –spontaneous and induced mutation. DNA damage & repair mechanism. Molecular Markers.

References

1. Freifelder, D., 2005. Molecular biology. 2nd Ed. Narosa Publishing House, New Delhi.
2. Freifelder, D., 2006. Microbial Genetics. 2nd Ed. Narosa Publishing House, New Delhi
3. Maloy, S.R., Cronan, J.E. Jr. and Freifelder, D. Microbial Genetics, 2ndEd. Jones and Bartlett Publishers.
4. Tamarin, R.H., 2004. Principles of Genetics, 7th Ed. Tata Mc Graw Hill publishing house, New Delhi.
5. Lewin, B. 2004. Genes VIII. Pearson Prentice Hall, USA.
6. Klug, W.S. and Cummings, M.R., 1996. Essentials of Genetics. Prentice Hall, New Jersey

PAPER VI - VIROLOGY AND NANOTECHNOLOGY

UNIT I

General properties and Classification of Viruses. Cultivation of viruses – Egg Inoculation – Animal Inoculation and Tissue culture methods. Isolation and Purification of Viruses. Characterization and Enumeration of viruses – Quantitative assay.

UNIT II

Structure, genome replication, protein synthesis and assembly of: DNA containing bacteriophages – T4, lambda, Mu, ΦX174 & M13 phages and RNA containing bacteriophages - MS2 and Φ6 group.

UNIT III

General properties, structure, genome replication, protein synthesis and assembly, pathogenesis and laboratory diagnosis of : DNA containing animal viruses - Adeno viruses, Herpes viruses, Pox viruses – Variola virus. RNA containing animal viruses: Picorna virus, Rhabdo virus, Hepatitis viruses, Orthomyxo virus – Influenza H1N1, Paramyxovirus, Retroviruses - HIV and Rubella virus. Arbo virus – Dengue virus, Ebola virus, Prions.

UNIT IV

Classification - General properties, structure, genome replication, protein synthesis and assembly of: DNA containing plant viruses – CaMV and Gemini Virus - RNA containing plant viruses - TMV, Cowpea mosaic viruses, Bromo mosaic viruses and Satellite viruses

UNIT V

Nanotechnology: Biological nanoparticle production – Plants and Microbial, Nanobiotechnological application in health and disease, Nanobiotechnological application in environment and food.

References

1. Luria. S.E. Darnall. J.E. Baltimore. D. and Compare. A. 1978. General Virology, 3^{ed}.
2. Freidfelder ,D. 1995. Microbial genetics.
3. Grierson. D. and S.Convey, 1989. Plant Molecular Biology, 2^{ed}.
4. Hayes. W. 1968. The Genetics of Bacteria and their Viruses.
5. Mundahar. C.L. 1987. Introduction to plant viruses. 2^{ed}.
6. Nanobiotechnology: Concepts, Applications and Perspectives (2004), Christof M. Niemeyer (Editor), Chad A. Mirkin (Editor), Wiley VCH.
7. Nanotechnology in Biology and Medicine: Methods, Devices and Applications (2007), Edited by Tuan Vo-Dinh, Tuan Vo-Dinh, CRC Press.

PAPER VII- BIOPROCESS TECHNOLOGY

UNIT I

An introduction to industrial microbiology- Types of fermentation- Component parts of fermentation process- Fermentation economics

UNIT II

Fermentor Design and construction, Fermentor types - For microbial and animal cell culture- Bioreactors for Aerobic fermentation , Stirred Bioreactors, Reactors for immobilized cells, Productivity, Yield coefficients, Heat production, Stirring and mixing, Gas exchange and mass transfer, Computer Applications in fermentation technology.

UNIT III

Industrially important microorganisms. Isolation (Primary and Secondary screening), Preservation and improvement of industrially important strains. Upstream processing – Development of inoculums for fermentation process- Media for industrial fermentation- Formulation, Optimization and Sterilization. Stages of upstream-Growth of inoculums, Fermenter preculture and Production fermentation.

UNIT IV

Down stream Processing- Recovery and purification of intracellular and extracellular products- Flocculation, Flootation, Filter systems, Centrifugation, Disintegration, Chromatography, Extraction, Crystallization, Precipitation and Drying.

UNIT V

Microbial production of commercially important products-Organic acid (citric acid, acetic acid)-Enzymes (Amylase and Protease) Amino acids (Lysine and Glutamic acid) Antibiotics (Penicillin) Vitamins (Riboflavin, cyanocobalamine and ascorbic acid. Biosynthesis of Ergot alkaloids. Microbial transformation-steroids and sterols. Non steroid compounds.

References

1. Stanbury P.F.A. Whitaker S.J.Hall, 1985 Principles of fermentation Techniques 2^{ed}.
2. Cruger and Cruger. A. Text Book of Industrial Microbiology 2^{ed}.
3. Cassida, J.E.1968.Industrail microbiology.
4. Prescott and Dunns, Industrial Microbiology.
5. Pepler.H.J.1979. Microbial Technology. Vol I and II.
6. Demain A.J. and Solomon INA, 1986. Manual of Industrial Microbiology and Biotechnology.

PAPER VIII - ENGINEERING OF GENES AND PROTEINS

UNIT I

Cloning: Isolation and purification of nucleic acids (chromosomal DNA, RNA & Plasmids) – Methods of handling and quantification of DNA and RNA. Blotting – types of blotting – Southern, Northern and Western Blotting. Chromosome walking.

UNIT II

Restriction endonucleases – types and characteristics - DNA methylases - Ligases – Adapters, Linkers and Homopolymer tailing – Transformation techniques: electroporation, microinjection, protoplast fusion and microparticle bombardment - Screening: Direct: Insertional inactivation, plaque phenotype and indirect methods: Immunochemical detection, nucleic acid hybridisation, Dot and Colony Blotting. Genomic DNA libraries - cDNA libraries.

UNIT III

Vectors – properties - types of vectors – plasmids– host range and incompatibility – Vectors constructed based on bacteriophages (M13 & Lambda), cosmids, phasmids, phagemids and BACs - Eukaryotic vectors - Yeast vectors (YAC) – animal (retroviruses, adenoviruses) and plant vectors (Ti plasmid based vectors and caulimoviral vector) – expression vectors - shuttle vectors - Expression of genes in bacteria, animal, plant, algae & fungi.

UNIT IV

Characterization of cloned DNA: Restriction mapping - restriction fragment length polymorphism (RFLP) - Polymerase chain reaction (PCR) - Types of PCR and their applications. DNA sequencing: Primer walking, Maxam and Gilbert method, dideoxy method, automated sequencing and micro array.

UNIT V

Site directed mutagenesis, Design and construction of novel proteins and enzymes, Basic concepts in enzyme engineering, engineering for kinetic properties of enzymes. Introduction to drug designing, Protein structure based drug design, protein folding, protein sequencing, peptide sequence data, protein crystallization. Data analysis- Mass spectrometry based methods for protein identification, MALDI-TOF, 2D gel electrophoresis.

References:

1. Old. R. W. and Primrose S.B. 1995. Principles of gene manipulations – An introduction to genetic engineering , 5^{ed}.
2. Winnacker E.L, 1987, From Genes to Clones. – Introduction to gene technology. Nicholl. D.S.T, 1994. An introduction to genetic engineering.
3. Brown. T.A. 1995. Gene Cloning.
4. Pinler. A. 1993. Genetic engineering of microorganisms.
5. Protein Structure, Stability and Folding by Kenneth P. Murphy. Published by Humana Press Inc. 2001.
6. Protein Engineering Principles and Practice by Jeffrey L. Cleland and Charles S. Craik. Published by Wiley-Liss Inc., 1996.
7. Protein Engineering and Design by Paul R. Carey. Published by Academic Press Inc., 1996.

M.Sc. MICROBIOLOGY

PRACTICAL II

1. Wine production
2. Organic acid production – Citric acid – Solid state and submerged fermentation.
3. Production of Extra cellular enzymes – Protease by submerged fermentation – Cellulose by solid state fermentation.
4. Isolation of nitrogen fixers – free living, symbiotic, ammonification, nitrification, denitrification.
6. Isolation of Phosphate solubilizers.
7. Isolation of Coliphage.
8. Microbial decolourisation of textile dyes.
9. Phage titration.
10. TMV transformation
11. Isolation of mutants: Auxotrophic and Antibiotic resistant mutants.
12. Isolation of Plasmids and chromosomal DNA from microbes.
13. Size determination and fractionation of nucleic acids and proteins – Agarose gel electrophoresis, SDS – PAGE.
14. Restriction mapping of γ of Vector DNA.

SEMESTER III
PAPER IX - IMMUNOLOGY & IMMUNOTECHNOLOGY

UNIT I

Historical background and scope of immunology, Immunohaematology -ABO and Rh factor. Cells and organs of immune system. Defence mechanisms of human body: Primary, Secondary and tertiary line. Types of immunity - HI and CMI

UNIT - II

Antigens - properties, Epitopes, haptens, adjuvant, cross reactivity. Antibodies - properties, structure and isotypes. Diversity and specificity

UNIT - III

Serology - Introduction and classification of antigens and antibody reactions - Agglutination and precipitation reaction. Strength of antigen and antibody bindings - affinity & avidity. Monoclonal antibodies and their applications. Complement pathway and complement fixation reaction. Immunofluorescence RIA, RAST, ELISA and Flowcytometry.

UNIT - IV

MHC antigens - types and functions. Response of B Cell to antigens. T cell products. Immunity to infectious diseases - Viral, bacterial and protozoan . Hyper sensitivity reactions.

UNIT V

Transplantation immunology - Tissue transplantation and grafting . Mechanism of graft acceptance and rejection. HLA typing Tumor immunology. Immunodeficiency diseases: Primary immunodeficiency disorders: severe combined immunodeficiency (SCID disorders) and Secondary immunodeficiency disorders: AIDS, cancers of the immune system, leukemia, viral hepatitis - auto immunity: mechanism, types: Rheumatoid arthritis, Systemic lupus erythematosus, Multiple sclerosis and myasthenia gravis. Vaccines - Types and vaccination methods.

References

1. Coleman, R.M. , Lourbard, M.F and Sicard, R.E., 1992. Fundamental immunology, 2nd edition
2. Kuby, J. 1997. Immunology, W.H Freeman and co., New York.
3. Roitt, I.M. 1988. Essential of Immunology, Black Well Scientific Publishers.
4. Tizard, R.I. 1983. Immunology - An introduction , Saunder's College publishers Philadelphia.
5. Roitt's Essential Immunology. Wiley-Blackwell. 12th Edition

PAPER – X - MEDICAL MICROBIOLOGY

UNIT I

Introduction to medical microbiology - Infectious Diseases process – Diagnosis – Process of sample collection, transport and examinations of clinical specimens. Antibioqram and serological test. Virulence factors of bacteria – Host parasite relationship.

UNIT II

Bacteriology: Gram positive organisms - Morphology, cultural characteristics, pathogenicity and laboratory diagnosis of *Staphylococcus aureus*, *Streptococcus pyogenes*, *Pneumococcus*, *Bacillus anthracis*, *Corynebacterium diphtheriae*, *Clostridium tetani*, *Clostridium botulinum*, *Mycobacterium tuberculosis*, *Mycobacterium leprae*. *Spirochaetes* – *Treponema pallidum*, and *Leptospira icterohaemorrhagiae*.

UNIT III

Bacteriology: Gram negative organisms:- Morphology, cultural characteristics, pathogenicity and laboratory diagnosis of *E. coli*, *Klebsiella pneumoniae*, *Salmonella typhi*, *Shigella dysenteriae*, *Pseudomonas aeruginosa*, *Vibrio cholerae*, *Bordetella pertussis*, *Yersinia pestis*, *Neisseria gonorrhoeae*, and *Neisseria meningitidis*.

UNIT IV

Mycology: General properties and approaches to laboratory diagnosis. Mycosis – Superficial, Subcutaneous and Systemic infections – Cryptococcosis, Madura mycosis, Histoplasmosis, *Candida albicans*, Aspergillosis and Blastomycosis.

UNIT V

Parasitology: Life cycle, Pathogenicity and laboratory diagnosis of *Entamoeba histolytica*, *Trichomonas vaginalis*, *Plasmodium vivax*, *Leishmania donovani*, *Taenia solium*, *Ascaris lumbricoides*, *Enterobius vermicularis* and *Wucheraria bancrofti*.

References

1. Textbook of Microbiology – Ananthanarayanan and Jayaram Panicker.
2. Essentials of Diagnostic Microbiology – Lisa Anne Shimeld, Anne T. Rodgers,
3. Manual of Clinical Microbiology – Lenetle, E, Balows H.A.
4. Textbook of Medical Parasitology – Subash. C. Parija.
5. Medical Microbiology - Geo. F. Brooks. S Medical Mycology – Jagadesh Chander.

PAPER XI – BIOTECHNOLOGY AND IPR

UNIT I

Microbial Production of Therapeutic Agents and Vaccines: Emergence of molecular biotechnology – Commercialization – concerns and consequences - Pharmaceuticals - interferons and growth hormones, enzymes: DNase I and alginate lyase, Monoclonal antibodies - HIV therapeutic agents. Subunit vaccines: Herpes simplex virus, Foot and mouth disease virus, TB, Peptide vaccines – genetic immunisation – attenuation through recombinant DNA technology, vector vaccines.

UNIT II

Synthesis of Commercial Products by Recombinant Microorganisms: Restriction endonucleases: *Pst*I, Small biological molecules: Indigo, Antibiotics: Synthesis of Novel antibiotics. Biopolymers: Xanthan gum, Melanin, byssal adhesive, rubber and PHA.

UNIT III

Microbial Biotechnology: Plant growth promoting bacteria (PGPR) – genetic engineering of nitrogenase gene cluster, hydrogenase and Nodulation. Biocontrol of pathogens: Siderophores, antibiotics and enzymes. Release of genetically engineered organisms - Ice nucleation and anti-freeze proteins. Microbial insecticides: Insecticidal toxin of BT - genetic engineering of BT strains – Baculovirus.

UNIT IV

Plant Biotechnology: Genetic engineering of plant: Ti Plasmid, Ti plasmid derived vector systems – microprojectile bombardment – Development of insect, virus and herbicide resistant plants, stress and senescence tolerant plants, modification of flower pigmentation, nutritional content, discoloration and sweetening by genetic engineering. Plant as bioreactors.

UNIT V

Animal Biotechnology and IPR: Transgenic animals: methods of creating transgenic mice, cattle and sheep. Human gene therapy – *in vivo* and *ex vivo* gene therapy – gene delivery system. Molecular diagnostics for genetic diseases. Regulating the use of biotechnology: recombinant DNA Technology, food and agricultural ingredients, human gene therapy, deliberate release of genetically engineered organisms. Biosafety and Bioethics. Intellectual Property Rights: Patents - copy right and neighboring rights, patents for invention, trademarks, trade names Conditions for patentability - Drafting and filing a patent application, infringement, copyright and development, exploitation of patented invention. Indian patent laws.

References

1. Glick, B. R and Pasternak, J.J. 2003. Molecular Biotechnology – Principles and Applications of Recombinant DNA. ASM Press, Washington D.C.
2. Winnacker E.L., 2003. From Genes to Clones – Introduction to Gene Technology. First Indian reprint, PANIAMA publishing Co-operation, New Delhi.
3. Old, R.W. and Primrose, S.B. 1995. Principles of Gene Manipulation - An Introduction to Genetic Engineering 5th Ed. Blackwell Scientific Publications, London.
4. Brown T A., 2001. Gene cloning and DNA analysis introduction. 4th Ed. Blackwell Science Ltd., London.
5. Watson, J. D., Gillman, M., Iknowski, J and Zollar, M 2001. Recombinant DNA. 2nd Ed. Scientific American Books, WH freeman and Company, New York.

PAPER XII - MICROBIAL FOOD TECHNOLOGY

UNIT I

Food as a substrate – Incidence and types of microorganisms in food – Contamination and Spoilage of Meat, Poultry, Sea foods, Vegetables, Fruits. Principles of food preservations: Asepsis, Preservation by use of High temperature, Low temperature, Canning, Drying, Radiation and Food additives.

UNIT II

Food poisoning – Food borne diseases- Bacterial and Non- Bacterial. Fermented foods - Meat and fishery products – Country cured hams, Dry sausages, idli batter and sauerkraut. Fermented milk products – Butter, Butter milk, Sour cream, Youghurt and Cheese.

UNIT III

In house Committee for quality assurance, Persons involved, Internal Microbial Quality control Policy, Quality Check at every step from collection of raw materials till it reaches the customer , Implementation of ISO standards, definitions, principles and use of HACCP in Food Industry .

UNIT IV

Indicator organisms – Direct examination – culture techniques – enumeration methods – plate – Viable & Total Count; Alternative methods – Dye reduction tests , electrical methods , ATP determination: Rapid methods, immunological methods – DNA / RNA methodology – Laboratory accreditation.

UNIT V

Food laws and regulations

- A. National – PFA Essential Commodities Act (FPO, MPO etc.)
- B. International – Codex Alimentarius, ISO – 9000 series , ISO 22000 & BS 5750.
- C. Regulatory Agencies – WTO

Consumer Protection Act - Relevance of Microbiological standards & criteria for food safety – Sampling plans – Microbiological guidelines

Hygiene and sanitation in food sector

General Principles of Food Hygiene, GHP for commodities, equipment, work area and personnel, cleaning and disinfect ion (Methods and agents commonly used in the hospitality industry).

References

1. James. M. Jay, 1992, Modern food microbiology 4^{ed}.
2. Frazier, W. C. and Westhoff D.C. 1989. Food Microbiology 8^{ed}.
3. Dubey. R.C. and Maheswari. D.K. A Textbook of Microbiology, 1999. 1^{ed}.
4. Food Microbiology. 2nd Edition – M.R.Adams & M.O.Moss – Panima Publishers.

PAPER XIII - BIOSTATISTICS AND RESEARCH METHODOLOGY

UNIT I

Definition – Scope of Biostatistics, Probability analysis, Variables in Biology-Collection, Classification and Tabulation of data. Graphical and diagrammatical representation –Scale diagram - Histogram- frequency curve.

UNIT II

Measures of central tendency - Arithmetic mean, Median, Mode. Calculation of Mean, median, Mode in series of individual observations, discrete series, continuous, open end classes, measure of dispersion, standard deviation, standard error.

UNIT III

Simple correlation coefficient, correlation regression- simple and linear.

UNIT IV

Basic ideas of significant test-Hypothesis testing, Level of significant test, test based on studies-t-test- chi square, Goodness of fit.

UNIT V

Plagiarism and research ethics. Selection of research problem – Formulation of research objectives - project design - review of literature writing - Sources of data collection for biosciences research - processing of data - presentation of data - editing – preparation of master's thesis. Presenting the research findings in open defense.

References

1. S.P. Gupta-Statistical Methods
2. Palanisamy and Manoharan-Statistical methods of Biology
3. Khan and Khan- Fundamentals of Biostatistics
4. Kothari-Research Methodology

**M.Sc. MICROBIOLOGY
PRACTICAL III**

1. Diagnostic Microbiology: Isolation and identification of pathogens from clinical specimens like urine, pus, faeces, sputum, CSF, blood and discharges.
2. Isolation and identification of clinically important fungi - *Candida albicans*, *Aspergillus sp*, *Cryptococcus neoformans*
3. Antibiotic susceptibility test. - Kirby Bauer technique
4. Identification and enumeration of Lymphocytes.
5. Examination of blood smear study for *Plasmodium sp*
6. Agglutination reaction - Blood grouping & Rh Typing – Cross matching demonstration.
7. Precipitation reaction – ODD Test.
8. Serological Tests – WIDAL (Slide & Tube Test), RA, ASO, CRP, RPR.
9. Pregnancy Test – β -hCG.
10. Immunoelectrophoresis – Counter Current & Rocket Immunoelectrophoresis.
11. ELISA – HIV, HBV & HCV.
12. Separation techniques: Chromatography - Paper, TLC and Column.
13. Virus cultivation – Egg inoculation techniques.

GROUP A - ELECTIVE PAPER I: PRINCIPLES OF QUALITY ASSURANCE

UNIT I

Quality assurance – Introduction and overview – Definition. Designing of microbiology laboratory – Control of quality – Applications.

UNIT II

Quality assessment of Equipments, chemicals, glass wares and laboratory environments – Variance – Quality control calculations – Quality management – Maintenance of records and reports.

UNIT III

Quality assurance in sterilization and disinfection - Preservation of stock cultures, media and diagnostic kits – Quality control of media and stains.

UNIT IV

Quality assessment of disposal – decontaminated matters and other biological effluents – Quality management in transportations of cultures. National control of biologicals – Biological references and standards.

UNIT V

Good laboratory practices – Management of laboratory hazards and knowledge in First aid procedures.

Reference

1. Rajesh Bhatia and Rattan lal Ichhpujani. 1995. 1^{ed}. “Quality assurance in Microbiology”

GROUP A - ELECTIVE PAPER II - QUALITY ASSESSMENT IN PHARMACEUTICALS

UNIT I

An introduction to pharmaceutical microbiology. Chemical growth control. Chemical antimicrobial agents for external use, synthetic antimicrobial drugs, naturally occurring antimicrobial drugs: Antibiotics. Antibiotics from prokaryotes, antiviral drugs, antifungal drugs, antimicrobial drug resistance, the search for new antimicrobial drugs.

UNIT II

Types of spoilage, Factors affecting microbial spoilage – assessment of microbial spoilage – preservation. Ecology of microorganisms as it affects the pharmaceutical industry – Sterile pharmaceutical products – injections, Non injectable sterile fluids, Ophthalmic preparations, dressings & implants.

UNIT III

Sterilization control - methods of sterility testing- sterilization monitors and Quality assurance of products. The microbiological quality and regulatory requirements for natural and nutraceutical products, The regulatory control and quality assurance of immunological products, Containment system integrity – sterile products, Regulatory guidelines (microbiology) for veterinary antimicrobial products.

UNIT IV

The role of the Qualified Person in microbiological quality assurance, Safety in microbiology, Rapid enumeration and identification methods, Selection and use of cleaning and disinfection agents in pharmaceutical manufacturing, Prevention and elimination of microbial biofilms in the manufacturing environment using Clean-in-Place, Cleanroom design, operation and regulatory standards.

UNIT V

Microbiological quality assurance. Validation of aseptic processing and media fills, International disinfectant testing protocols, Measurement of biocide effectiveness, Microbiological quality and regulatory requirements for biotherapeutics and manufactured products, The role of the microbiologist in HACCP, Auditing the pharmaceutical microbiology department.

References

1. Pharmaceutical Microbiology – W.B.Hugo & A.D.Russel, 4 th Ed, Blackwell Scientific Publications.
2. INDUSTRIAL PHARMACEUTICAL MICROBIOLOGY – Vol I & Vol II: Standards & Controls Editors – Dr Norman Hodges and Professor Geoff Hanlon (University of Brighton) ,(REF ; www.euromed.uk.com)
3. Biology of Microorganisms – BROCK-Madigan M.T. 11th Edition (2006) Pearson-Prentice Hall, USA

GROUP A – ELECTIVE PAPER III - TOTAL QUALITY MANAGEMENT (TQM)

UNIT – I

Concepts in TQM- Tools & techniques of TQM – Requirements for implementing TQM – Steps for implementing TQM – Questionnaire, Assessment through questionnaire – Mission statement – Benefits of TQM – Check list for implementing TQM – Case study.

UNIT -II

Types of Data, tabular and **Graphical summarization of numeric data:** - Histograms & Stem and Leaf displays : **Graphs for categorical data** – Bar, Pie charts & Pareto diagrams.

UNIT – III

Graphs for time ordered data – Run charts, Cause effect diagrams – Check Sheets

UNIT –IV

Numeric data summarization - The mean, mode & Median; The Standard deviation, Variance, Range & Percentiles.

UNIT -V

Graphic display of numeric summaries:-The box plot and the scatter diagram. Skewness, T – test, Anova,

References

1. Twelve Management skills for success – Ram Narain , Viva books private limited – Chennai.
2. A cross functional perspective Total Quality Management – Rao, Carr, Dambolena and Kopp- John Wiley & Sons, New York .

GROUP A
ELECTIVE PAPER IV - PRACTICAL

1. Microbiological laboratory safety- General rules & Regulations.
2. Staining Techniques (Grams and LPCB)–Food samples- vegetables and packed foods.
3. Sterility tests for Instruments – Autoclave & Hot Air Oven
4. Disinfection of selected instruments & Equipments
5. Sterility of Air and its relationship to Laboratory & Hospital sepsis.
6. Sterility testing of Microbiological media
7. Sterility testing of Pharmaceutical products –Antibiotics, Vaccines & fluids
8. Standard qualitative analysis of water.
9. Quantitative analysis of water – Membrane filter method
10. Analysis of food samples for Mycotoxins (Afla toxins)
11. Enumeration of microbes from industrial effluents.
12. Evaluation of Drug potency by MIC.
13. Isolation & characterization of Bacteria from wood and Paints.
14. Assay of microorganisms from biomedical waste.
15. Water quality analysis – MPN.
16. Estimation of BOD and COD.
17. Isolation of microorganisms from spoiled foods – Meat, milk, Cereals and Bread.
18. Milk quality – Dye reduction test.
19. Thermal death point and thermal death time.

References

1. Microbiology - A laboratory manual, Cappuccino & Sherman , 6 th Ed, Pearson Education
2. Manual of diagnostic microbiology, Dr.B.J.Wadher & Dr.G.L.Bhoosreddy, First .Ed., Himalaya publishing house, Nagpur.
3. Pharmaceutical Microbiology – W.B. Hugo
4. Pharmaceutical Microbiology – Purohit
5. Laboratory Exercises in Microbiology, George.A.Wistreich & Max.D.Lechtman, 3 rd Ed, Glencoe press, London.

GROUP B - ELECTIVE PAPER I - ENVIRONMENT AND HEALTH

UNIT I

Water pollutants – Purification – Mechanical and Chemical methods.

UNIT II

Air pollutants – Control of air pollution – Disinfection of air – Ventilation, UV radiation.

UNIT III

Noise pollution – Control measures, Radiations – Causes and Control

UNIT IV

Medical entomology: Vector control – Flies, fleas and Rodent Control

UNIT V

Environmental sanitation – Waste disposal – Sewage, Sludge and Hospital waste disposal

References

1. Park's Text book of Preventive and social medicine by Dr. Jahan Evertt Rark
2. Environmental Biology by S. K. Dubey
3. Environment Pollutants and Women's Health by Mahendra Pandey
4. Waste water Treatment by Sheela Sanghvi
5. Environment and Pollution by N. Arumugam and V. Kumerasan
6. Ecology and Ethology by V. K. Agarwal & Usha Gupta

GROUP B - ELECTIVE PAPER II - COMMUNICABLE AND NON-COMMUNICABLE DISEASES

UNIT I

Respiratory infections – Influenza, Mumps, Measles, Rubella, Acute respiratory infections and TB.

UNIT II

Intestinal infections – Polio, Cholera, Acute diarrhea diseases, Food poisoning, Typhoid, Amoebiasis, Ascariasis, Hook worm, Tapeworm, Pinworm infections.

UNIT III

Vector borne Infections – Leprosy, STD – AIDS – Diagnostic Techniques and Treatment.

UNIT IV

Superficial mycoses – Dermatophytoses – Opportunistic fungal infections – Candidiasis – Diagnostics Techniques and Treatment.

UNIT V

Non-communicable diseases – Hyper Tension – Diabetes – Coronary Heart diseases – Cancer, Obesity, Blindness, Accidents – Preventive measures.

References

1. Park's Text Book of preventive and social medicine
2. Medical Microbiology by K.C.Sawant
3. Virology by K.C.Sawant
4. Bacteriology by Subrata Bhattacharjee
5. Text book Microbiology by Ananthanarayan
6. Medical Microbiology by Panicker
7. A Text book of Microbiology by R.c.Dubey and D.K.Maheswari

GROUP B - ELECTIVE PAPER III - HEALTH CARE OF THE COMMUNITY

UNIT I

Nutrition and health - Balanced Diet, food surveillance, food fortifications- addition of vitamins and minerals - Adulteration and preventive steps.

UNIT II

Physical health-care of skin, hair, teeth, eyes, ears, hands and feet-physical exercises and their importance - Walking and jogging – Yoga and meditation – stress Relief.

UNIT III

Health Programmes and health education – Malaria control – TB control – AIDS control programmes and Immunization programmes.

UNIT IV

Social sciences and mental health – Sociology; Social structure, culture and customs – social problems-Mental health – cases of mental illness Alcoholism and drug dependence – prevention Rehabilitation.

UNIT V

Family planning, Maternal and child health – Antenatal and Postnatal care – Reproductive and child Health programme (RCH).

References

- 1.Park's Text books of preventive and social medicine
- 2.Immune – biotechnology by Naha & Narain
- 3.Immunology by Dulsy Fatima & N.Arumugam
- 4.Food and Nutrition by L.Swaminathan
- 5.Dietics by Srilakshmi
- 6.Practice of fertility control & Comprehensive manual 6th edition by S.K.Choudhary

GROUP B - ELECTIVE PAPER IV - PRACTICAL

1. Water Analysis : Physicochemical parameters
2. Bacteriology: Hanging drop method, Gram's staining, and pasteurization of milk.
3. Diagnostic test : Diabetic test, Hypertension test, Widal test, VDRL test
4. Sterilization techniques: Autoclave, Hot Air oven
5. Food Adulteration Any four Food Stuffs
6. ELISA test, RIA test (Demonstration only)
7. Microscopic examination of Infectious Agents- Entamoeba, Ascaris, Hook worm, Pinworm, Tape worm, malarial parasite and Filarial parasite.

GROUP C - ELECTIVE PAPER I - BASIC BIOLOGICAL SCIENCES

UNIT-I

Cell Biology - Structure and function of cells and intracellular organelles (of both prokaryotes and eukaryotes): mechanism of cell division including (mitosis and meiosis) and cell differentiation: Cell-cell interaction; Dosage compensation and mechanism of sex determination.

UNIT-II

Biochemistry: Structure of atoms, molecules and chemical bonds; Principles of physical chemistry: Thermodynamics, Kinetics, dissociation and association constants; Nucleic acid structure, genetic code, replication, transcription and translation: Structure, function and metabolism of carbohydrates, lipids and proteins; Enzymes and coenzyme; Respiration and photosynthesis.

UNIT-III

Physiology: Response to stress: Active transport across membranes; Plant and animal hormones: Nutrition (including vitamins); Reproduction in plants, microbes and animals.

UNIT-IV

Evolutionary Biology: Origin of life (including aspects of prebiotic environment and molecular evolution); Concepts of evolution; Theories of organic evolution; Mechanisms of speciation; Hardyweinberg genetic equilibrium, genetic polymorphism and selection; Origin and evolution of economically important microbes, plants and animals.

UNIT-V

Environmental Biology: Concept and dynamics or ecosystem, components, food chain and energy flow, productivity and biogeochemical cycles; Types of ecosystems, Population ecology and biological control; Community structure and organization; Environmental pollution; Sustainable development; Economic importance of microbes, plants and animals.

GROUP C - ELECTIVE PAPER II – BIOPHYSICS AND BIOCHEMISTRY

UNIT-I

Principles of biophysical methods used for analysis of biopolymer structure, X-ray diffraction, Hydrodynamic methods; plasma emission spectroscopy.

UNIT-II

Principles and techniques of nucleic acid hybridization and Cot curves; Sequencing of Proteins and nucleic acids; Methods for measuring nucleic acid and protein interactions. Structural polymorphism of DNA, RNA and three dimensional structure of tRNA.

UNIT-III

Principles and applications of tracer techniques in biology; Radiation dosimetry; Radioactive isotopes and half life of isotopes; Effect of radiation on biological system.

UNIT-IV

Interconversion of hexoses and pentoses; Amino acid metabolism; Coordinated control of metabolism; Oxidation of lipids; Biosynthesis of fatty acids; Triglycerides; Phospholipids; Sterols, Group transfer and Coupled reactions.

UNIT-V

Biochemistry and molecular biology of cancer; Oncogenes; Chemical carcinogenesis; Genetic and metabolic disorders; Hormonal imbalances; Drug metabolism and detoxification.

**GROUP C - ELECTIVE PAPER III
MOLECULAR CYTOLOGY AND TISSUE ENGINEERING**

UNIT-I

Molecular basis of signal transduction in bacteria, plants and animals; Model membranes; protein sorting, secretory and endocytic pathways, cell cycle; Dosage compensation and sex determination and sex-linked inheritance

UNIT-II

The law of DNA constancy and C-value paradox; Numerical, and structural changes in chromosomes; Molecular basis of spontaneous and induced mutations and their role in evolution; polypoidy; Environmental mutagenesis and toxicity testing; Population genetics. Environmental regulation of gene expression

UNIT-III

Cell and tissue culture in plants and animals; Primary culture; Cell line; Cell clones; Callus cultures; Somaclonal variation; Micropropagation; Somatic embryogenesis; Haploidy; Protoplast fusion and somatic hybridization; Cybrids;

UNIT-IV

Gene transfer methods in plants and in animals; Transgenic biology; Allopheny; Artificial seeds; Gene targeting. Applications of genetic engineering in agriculture, health and industry.

UNIT-V

Histology –Basics of mammalian systems, nutrition, digestion and absorption; Circulation (open and closed circular, lymphatic systems, blood composition and function); Excretion and osmoregulation: Homeostatis (neural and hormonal); Bioluminescence.

GROUP C - ELECTIVE PAPER IV – PRACTICAL

1. Stages of cell division-mitosis and meiosis
2. Estimation of total carbohydrates and proteins
3. CS of dicot and monocot root and stem
4. Physical mutation with UV
5. Antagonistic activity of any one biocontrol agent.
6. Agarose gel electrophoresis
7. Agglutination-Blood grouping, Precipitation-ODD
8. Callus induction
9. Auxin production
10. Phenomenon of Bioluminescence.