

M.Sc. Sem. I to Sem. IV

Prospectus No. 2009128

संत गाडगे बाबा अमरावती विद्यापीठ

SANT GADGE BABA AMRAVATI UNIVERSITY

विज्ञान विद्याशाखा  
(FACULTY OF SCIENCE)

अभ्यासक्रमिका  
विज्ञान पारंगत परिक्षा (सुक्ष्मजीवशास्त्र)  
सत्र-१ ते सत्र-४

**PROSPECTUS**  
OF  
MASTER OF SCIENCE EXAMINATION  
IN MICROBIOLOGY  
Semester -I, Winter 2008,  
Semester -II, Summer 2009,  
Semester -III, Winter 2009,  
Semester -IV, Summer 2010



2008

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**Syllabus Prescribed for  
M.Sc Part I Microbiology (Semester I)**

**THEORY**

Paper I	Microbial Techniques	50 Marks
Paper II	Microbial Enzymology	50 Marks
Paper III	Microbial Physiology and Photosynthesis	50 Marks
Paper IV	Environmental Microbiology	50 Marks

**PRACTICAL**

Practical I	Soil Microbiology	50 Marks
Practical II	Analytical Biochemistry and Instrumentation	50 Marks

**M. Sc Part I Microbiology (Semester II)**

**THEORY**

Paper V	Biostatistics, Bioinformatics and Computer Applications	50 Marks
Paper VI	Enzyme Technology	50 Marks
Paper VII	Microbial Metabolism	50 Marks
Paper VIII	Environmental Microbiology and Extremophiles	50 Marks

**PRACTICAL**

Practical III	Environmental Microbiology and Biodiversity	50 Marks
Practical IV	Microbial Enzymology, Biostatistics and Computer Applications	50 Marks

**M. Sc Part II Microbiology (Semester III)**

**THEORY**

Paper IX	Molecular Biology	50 Marks
Paper X	Virology	50 Marks
Paper XI	Fermentation Technology	50 Marks
Paper XII	Immunology	50 Marks

**PRACTICAL**

Practical V	Fermentation Technology	50 Marks
Practical VI	Immunology and Medical Microbiology	50 Marks

**M. Sc Part II Microbiology (Semester IV)**

**THEORY**

Paper XIII	Biotechnology	50 Marks
Paper XIV	Clinical Virology	50 Marks
Paper XV	Microbial Technology	50 Marks
Paper XVI	Medical Microbiology	50 Marks

**PRACTICAL**

Practical VII	Applied Microbiology and Biotechnology	50 Marks
Project	Project Work	50 Marks

**Notes:**

**The practical schedule of M.Sc. (Microbiology) should be as follows:**

1. Each practical in M.Sc. Part I should be of 8 hours duration per week (4 hrs /day for two consecutive days).
2. Each practical in M.Sc. Part II (Practical II, project work & I) should be of 8 hours duration per week (8 hrs/days) for two days).
3. Atleast 70% practicals should be performing during each semester.
4. Examination of each practical should be at least for 10 Hr. (Split over two days)

**M.Sc. Part I (Semester I) (MICROBIOLOGY) EXAMINATION**

**PAPER-I**

**MICROBIAL TECHNIQUES**

- UNIT-I : **Biological Relevance of pH and Buffers:-** The pH depends ionization of amino acids and proteins. Isoionic and isoelectric points. Effects of the pH change on non-protein protoplasmic components. The pH and metabolic reactions involving proton.
- UNIT-II : **Absorption and Emission of Radiation:** Principles laws of absorption of radiation, visible ultraviolet and infrared Spectrophotometry. Absorption spectra, fluorescence, fluorometry, flame photometry, NMR, ESR.
- Unit III **Isotopic Tracers techniques in Biology:-** Stable and radioactive isotopes, preparation, labeling, detection and measurement of isotopes. Dilution technique, Kinetics of radioactive disintegration.
- UNIT-IV : **Chromatography:** Paper, Column, thin layer, Gas, Ion exchange and affinity chromatography, Gel filtration.
- UNIT V **Electrophoresis:** Moving boundary, Zone (paper, gel etc.) electrophoresis. Immunoelectrophoresis, Isoelectric focussing.

**PAPER-II**

**MICROBIAL ENZYMOLOGY**

- UNIT-I: **GENERAL INTRODUCTION:**
- a) Introduction of Enzymology, Various terminologies, Properties of enzymes.
  - b) Enzymes as catalyst.
  - c) Enzyme activity units.

- Unit II : a) Enzyme isolation and purification - Importance of purification, Methods of Purification and fractionation.  
 b) Criteria of purity of enzymes - Tests of homogeneity.  
 c) Classification, of enzymes - IUB nomenclature.  
 d) Constitutive, Inducible and marker enzymes.
- Unit-III: **ENZYME KINETICS:**  
 a) Importance of Kinetic Study  
 b) Effect of Enzyme concentration on progress curves.  
 c) Effect of pH and Temperature.  
 d) Effect of Substrate concentration - Concepts of ES complex, Steady state and Rapid state equilibrium kinetics, Derivation of Henry - Michaelis - Menten equation of rectangular hyperbola, Significance of V<sub>max</sub> and K<sub>m</sub>, Transformation of H.M.M. equation to a straight line equation, Construction of Lineweaver - Burk Plot, Single and Double reciprocal plots, Limitations of H.M.M. equation, Sigmoidal saturation kinetics, Co-operatively of an enzyme, Hill's equation, steady kinetics (Haldane and Briggs' equation).  
 e) Bisubstrate enzyme kinetics.
- UNIT IV a) Types of inhibitors (reversible and irreversible), Kinetics of enzyme inhibition (competitive, non-competitive, uncompetitive and mixed inhibitors), Graphical presentation of inhibition effects.  
 b) Kinetics of reversible reactions (Haldane's relationship)  
 c) Mechanism of action of lysozyme.  
 d) Enzyme activators, Co-enzymes and Co-factors in enzymatic catalysis.
- Unit-V: **MECHANISM OF ENZYME ACTION :**  
 a) Concept of enzyme and substrate specificity.  
 b) Chemistry of active Centre, chemical modification by active site directed reagents.  
 c) Factors affecting catalytic efficiency of enzymes-covalent proximate, orientation, distortion or strain, acid-base and nucleophilic effects.  
 d) Various theories of mechanism of enzyme action.  
 e) Mechanism of action of lysozyme.

### PAPER-III

#### MICROBIAL PHYSIOLOGY AND PHOTOSYNTHESIS

- UNIT-I : **Membrane Transport :** Structure and organization of biological membranes. Types of cellular transport, Passive, facilitated, Active, Group translocation, membrane bound and binding protein transport systems. Carrier models.

- Liposomes. Ion transduction NaK<sup>+</sup>, ATPase.
- Unit II : **Energy metabolism:** ATP cycle, Free energy, standard free energy change, conventions in biochemical energetic, Calculation of DG. Standard free energy of hydrolysis of phosphate, compounds, Reservoirs of high-energy phosphate groups, Energy rich bonds, Biological energy transducer.
- UNIT-III : **Bacterial and Mitochondrial respiration:** Respiratory chain in mitochondria and bacteria, Oxidation-reduction enzymes. Respiration linked proton translocation.
- Unit IV : **Oxidative phosphorylation:** Coupling of oxidative phosphorylation to electron transport. Uncouplers, inhibitors, Reactions of oxidative phosphorylation, Mechanisms of oxidative phosphorylation. Chemical coupling, Conformational coupling and chemiosmotic coupling mechanism
- Unit V **Microbial photosynthesis:** Structure of photosynthetic pigments, Primary photochemistry PS I & PS II and electron transport. CO<sub>2</sub> fixation in bacterial photosynthesis, Anoxygenic and oxygenic photosynthesis, Halobacterial photosynthesis

### PAPER-IV

#### ENVIRONMENTAL MICROBIOLOGY

- UNIT-I : **An Introduction :** Definition of environment, Interaction between environment and biota, Concept of the habitat in biosphere, Food Chain, Ecosystem, Community, homeostasis and ecosystem management.  
**Concept of sustainable development of ecosystem:** Definition and Need of Sustainable developments. Role of bacterial technology in achieving sustainable development. Improvement and restoration of barren/degraded land. Pollution control, Renewable source of energy and fuel using microorganisms, biodiversity and its conservation
- UNIT-II : **Advancement in Biogeochemical cycles :**  
**Nitrogen cycle :** Symbiotic and non-symbiotic 'N' fixation, Mechanism of nitrogenase, cross inoculation group and host specificity, energy input/output ratio of 'N' fixation process in crop production, Biochemistry of Nitrate reduction.
- Unit III : **Phosphorus cycle :** Significance of 'P' element, Occurrence and solubilization in nature, role of phosphobacter and mycorrhizae in crop production.

**Carbon cycle** - General aspects, generation and decay of detritus 'C' compounds, features of plant cell wall polysaccharides, cellulose & lignin degrading microorganisms, mechanism of enzymes and its products. Carbonic anhydrase and its role in carbon cycle.

**Sulphur cycle** - Significance of 'S' compound, microbial sulphur metabolism, sulphur oxidizing bacteria and mechanism, distribution of sulphur bacteria in nature, Biochemistry of sulphate reduction.

**Selenium cycle** - Significance and occurrence, metabolism, deficiency and toxicity.

UNIT-IV : **Biochemistry and Microbiology of acid mine drainage:** Process of biochemistry, Iron oxidizing bacteria, Microbiology and Biochemistry of Metal and Metalloid transformation- ecological succession and control. Transformation of mercury, arsenic lead and tellurium. Biotransformation of pesticides.

Unit V **Biodeterioration** : Concept of biodeterioration. Biodeterioration of Wood, Metal, pharmaceutical products and Stone Work.

**Bioleaching:** Introduction, application of bacterial leaching, leaching techniques, prospective of bioleaching.

### PRACTICAL-I Soil Microbiology

1. Study of antagonism in microorganism from soil.
2. Isolation of soil microorganisms.
3. Isolation, Identification, Enumeration of Nitrogen fixing microorganism from soil, rhizosphere, phyllosphere and root nodule.
  - a) Isolation of *Azotobacter* spp and *Azospirillum*
  - b) Isolation and cultivation of *Rhizobium* from soil and roots nodules.
  - c) Nodulation of legume roots - Leonard jar experiment.
  - d) Isolation of cyanobacteria
  - e) Isolation of phosphobacteria from soil.
4. Estimation of nitrogen by kjeldhal method.
5. Preparation of biofertilizer/Biopesticides, enumeration of titer inoculum
6. Application of bioinoculant through seed, seedling and soil test under pot condition.
7. Isolation and microscopic examination of iron and sulphur bacteria.

### PRACTICAL-II ANALYTICAL BIOCHEMISTRY AND INSTRUMENTATION

1. Estimation of sucrose in presence of glucose.
2. Determination of pka of amino acids.
3. Estimation of proteins by biuret method.
4. Estimation of protein by Folin-Ciocalteu method.
5. Ultraviolet spectroscopy of proteins.
6. Absorption spectrum of p-nitro phenol
7. Paper chromatography of amino acids.
8. Paper chromatography of sugars.
9. Paper chromatography of purine and pyrimidine bases.
10. Separation of proteins by paper electrophoresis.
11. Separation of protein by gel electrophoresis.
12. Separation of pigments by adsorption chromatography.
13. Thin layer chromatography.
14. Estimation of DNA.
15. Estimation of RNA.

#### Distribution of marks in University Practical Examination:

1. Long Experiments	-	15 marks.
2. Short Experiment	-	10 marks
3. Viva-voce examination	-	05 marks
4. Spotting	-	05 marks
5. Practical record book	-	05 marks
6. Internal Assessment	-	10 marks
<b>Total</b>	<b>-</b>	<b>50 marks</b>

### M.Sc PART I (MICROBIOLOGY) EXAMINATION (Semester –II)

#### PAPER-V

#### BIostatISTICS, BIOINFORMATICS and Computer applications.

##### UNIT-I: Biostatistics :

- a) **Introduction:** Definition of Statistics, Statistical application in Biology, Types of statistics used in biology, sample statistics, test statistics, parametric Vs non-parametric
- b) **Sample and Sampling:** Introduction, selection of sample or sampling, theory-qualitative sample, random sample, non-random sample.
- c) **Graphical distribution of data:** Collection of data, classification of data, tabulation of data, graphic representation of data, diagrammatic representation of data

- d) Measures of Central tendency:** Measures of central tendency, Mathematical averages, - arithmetic mean, Geometric mean, Harmonic mean, Average mean- Median and Mode.
- e) Measures of Dispersion:** Definition, Range, Mean deviation, standard deviation, Standard error, Coefficients of variability, degree of freedom, confidence limit.
- Unit II:**
- a) Test of Significance:** Standard error of mean, standard error of standard deviation, student's t-test, chi-square test.
- b) Probability:** Definitions, types of probabilities, Rule of probabilities, Random variable, probability distributions, theoretical probability distributions.
- c) Correlation:** Meaning of correlation, Definition, Kinds, properties of coefficient of correlation, method of studying.
- d) Regression:** Introduction. Difference between correlation and regression, objects of regression analysis, kinds of regression analysis, linear regression, regression equation, coefficient
- e) Vital statistics:** Introduction, definition, methods of obtaining vital statistics, principles, measurements of population, measures of vital statistics, measurements of Mortality, life table.
- UNIT-III : Computer Fundamentals:**  
Basics of Computers, In-put and Out-put devices. Computer graphics. PC based software packages, Computer application in Microbiology / Biology. Computer's role, Modern computers, personnel computers, hardware, and software, Internet, Modem, freeware, Usenet, file transfer protocol, HTML, Browsers, Home page, URL, Search Engine, IP address.
- UNIT IV: Bioinformatics :**
- a)** Introduction, Definition, Importance, Analytical Approach, Application, Bioinformatics as tool, Role of bio and Chemo informatics in drug designs, Bioinformatics in life sciences, Studying bimolecular structures.
- b)** Biological Data base: Sequence database, Nucleic acid database, gene bank, proteins sequence data base, Swiss port, searching sequence data base, non reductant data base, Low annotation data base, specialized sequence data base, structure data base, motif database, proteome data base, Other data base
- c)** Sequence analysis:
- Unit V : Bioinformatics Tools and Application**

- a)** Tools for Bioinformatics: Pair wise alignment, Dotpots, scoring matrices, Blosum Matrices, PAM matrix, Gap penalty, Alignment Algorithms EMBOSS,
- b)** Proteins structure predictions: Secondary structure predictions, Tertiary structure Prediction, comparative modeling, folds recognition, Ab-initio prediction, Modeler, RASMOL.
- c)** Software in Bioinformatics: C/C, BioPerl, Biojava, BloXML, BioCorba, BioPython, BioDas, BioML, Oracle.
- d)** Emerging areas in Bioinformatics: DNA microarrays, Functional Genomics, Comparative Genomics, Pharmacogenomics, cheminformatics, Medical informatics, Neural networks, phylogeny, whole cell stimulation, Human genome project.

### PAPER-VI

#### ENZYME TECHNOLOGY

##### Unit-I : MECHANISM OF ENZYME ACTION :

- a)** Enzyme activators, Co-enzymes and Co-factors in enzymatic catalysis.
- b)** Concept of enzyme and substrate specificity.
- c)** Mechanism of action of lysozyme.

##### Unit-II : CONTROL OF ENZYME ACTION :

- a)** Regulation of enzyme activity-Feed-back control, enzyme introduction and repression, covalent modification.
- b)** Multienzyme complexes and their significance in metabolic control.
- c)** Membrane bound enzyme in metabolic regulation.

##### Unit III: Isoenzymes and their metabolic significance.

- e)** Allosterism - allosteric enzymes and Co-operativity.
- f)** Covalently modulated regulatory enzymes.

##### Unit IV: COMPARTMENTATION AND IMMOBILIZATION OF ENZYMES:

- a)** Compartmentation of enzyme and substrate and its significance, Shuttle systems.
- b)** Naturally occurring Activators, Inhibitors and Co-enzymes.
- c)** Methods of enzyme immobilization, Industrial advantages. Immobilized multi-enzyme system.
- d)** Kinetics of immobilized enzymes.
- e)** Enzyme probes.

##### Unit V: ENZYME TECHNOLOGY:

- a) Immobilization of Microbial enzymes:** Methods viz, adsorption, covalent bonding, entrapments and membrane

confinement and their analytical, therapeutic and industrial application, Properties of immobilized enzymes.

- b) **Enzyme engineering:** Chemical modification and site – directed mutagenesis to study the structure, function relationship of industrially important enzymes.
- c) **Application of microbial enzymes:** Microbial enzymes in textile, leather, wood industries and detergents, enzyme in clinical diagnostics, Enzyme sensor for clinical processes and environmental analyses, Enzymes as therapeutic agents.

#### PAPER-VII

##### MICROBIAL METABOLISM

- UNIT-I :** **Carbohydrate metabolism :** EMP, ED, HMP, and phosphoketolase pathways in different microorganism. Fate of pyruvate. Gluconeogenesis.  
**Tricarboxylic acid cycle:** Discovery, Intracellular location, Reactions of the cycle. Amphibolic nature. Anaplerotic reactions, Glyoxylate pathway.
- UNIT II :** **Aerobic metabolism of C1 Compounds:** Oxidation of methane, methanol, formaldehyde and formate. Ribulose pathways, Serine pathway, Xylulose monophosphate pathway.
- UNIT-III :** **Nucleotide metabolism:** Biosynthesis of purine and pyrimidine nucleotides, biosynthesis of deoxyribonucleotides, Regulation of nucleotide synthesis. Catabolism of nucleotides. Formation of coenzyme nucleotides. Inhibitors of nucleotide synthesis.
- UNITIV** **Microbial metabolism of aromatic compounds:** Ortho cleavage pathway, meta cleavage pathway, Gentisate pathway, reductive catabolism.  
**Catabolism of aromatic amino acids :** Tyrosine, Tryptophan, phenylalanine.  
**Lipid metabolism :** Biosynthesis of fatty acids, triacylglycerol, phosphoglyceride, sphingomyeline and sphingolipids. Oxidation of saturated and unsaturated fatty acids.
- UNIT-V :** **Protein metabolism:** Assimilation of inorganic nitrogen,  
**Biosynthesis of amino acids:** Branched chain amino acids, Aromatic amino acids, Sulphur containing amino acids, Basic amino acids.  
**Catabolism of amino acids:** Glutamine, glutamate, Aspartate, Asparagine, L-alanine, D-alanine, proline, Serine, Glycine, Arginine, polyamines, Valine, Leucine and Isoleucine, Threonine, Lysine, Methionine, Cysteine.

#### PAPER-VIII

##### ENVIRONMENTAL MICROBIOLOGY AND EXTREMOPHILES

- UNIT-IV :** **Recalcitrant organic compounds and concept of biomagnification:** Definition of recalcitrant organic compounds and their presence in natural ecosystem, concept and consequences of biomagnification, biomagnification of chlorinated hydrocarbons and pesticides. Biodegradation of recalcitrant and toxic chemicals.
- UNIT II :** **Eutrophication, and its management:** Eutrophication, Microbial changes induced by organic and inorganic pollutants, role of phosphorus and nitrogen in eutrophication, process and control of eutrophication.
- UNIT III :** **Extremophiles** - acidophilic, alkalophilic thermophilic, barophilic and osmophilic microbes - mechanisms and adoption. Halophiles - membrane variation - electron transport - application of thermophiles and extremophiles.
- UNIT-IV: Water Microbiology**
- a) **Water treatment Process,** Disinfections, kinetics of disinfections, factors affecting disinfecting drinking water, Halogens, (Chlorine, Chloramines, Chlorine di-oxide, Bromine and iodine) ozones, metal ions, Ultraviolet disinfections,
- b) **Water distribution systems,**
- c) **Concept of indicator organisms,** Total coliform, MTDT, MPN, MFT, P-A test, TTC, Fecal coliform, Fecal streptococci, Clostridium perfringens, Heterotrophic plate count, Bacteriophages, other indicator organisms, Standards and Criteria for indicators
- UNITV** **Waste water Management:** Introduction to primary, secondary and tertiary treatment, activated sludge process, trickling filters, principles of anaerobic digestion, Methane formation with respect to waste treatment, Oxidation pond and stabilization pond, application of sewage, Aerated lagoons.  
Biochemistry of nitrate and sulphate reduction with a special reference to waste treatment.

#### PRACTICAL-III

##### ENVIRONMENTAL MICROBIOLOGY AND BIODIVERSITY

1. Isolation of *Salmonella* from polluted water.
2. Isolation of phage from sewage water.
3. Assay of bacteriophages.

4. Demonstration of human enteric viruses.
5. Enumeration of coliform and faecal *Streptococci* by MF/MPN technique.
6. Examination and estimation of water for:
  - a) Ammonical nitrogen
  - b) nitrate
  - c) nitrite
  - d) dissolved oxygen
  - chlorides
  - f) sulphates
  - g) Chemical oxygen demand
  - h) biochemical oxygen demand
  - i) phosphates
  - j) calcium
  - k) magnesium
  - l) hardness
  - m) Alkalinity
  - n) solids-total dissolved & suspended
7. Enrichment of chemolithotrophs, methylotrophs, thermophiles, halophiles and acidophiles.
8. Enrichment and isolation of aliphatic hydrocarbon, phenol and parathion degraders
9. Study/Educational tour and submission of report.

#### PRACTICAL-IV

#### MICROBIAL ENZYMOLOGY, BIostatISTICS AND COMPUTER APPLICATION

1. Assay of following microbial enzymes.  
a) Amylase b) Lipase c) Protease d) Invertase
2. Isolation and purification of certain microbial enzymes such as: protease, amylase, invertase by salt fractionation, dialysis, ion exchange.
3. Evaluation of kinetic constants of the purified enzymes.
4. Effect of different parameters on enzymes activity such as:  
a) pH b) temperature c) time d) Enzyme concentration.
5. Effect of inhibitors on enzyme activity.
6. Fluidized bed column reactor using immobilized whole cell to study catabolism.
7. Immobilization of enzymes.
8. Students seminar and submission of report.
- b) BIostatISTICS:**
9. Organisation of data - frequency distribution.
10. Summarization of data -p describing a sample :  
Measures of central tendency - arithmetic mean, mode, median.(for grouped data)  
Measures of dispersion - variance and standard deviation.

11. Estimation of confidence interval for a normally distributed population.
12. Hypothesis testing - t-test, chi -square test, F-test.
13. Histograms.
- D) COMPUTER SCIENCE AND BIOINFORMATICS:**
- 14) Computer operations getting acquainted with different parts of computers.  
Handling WINDOWS and Internet, E-mail and Internet. Use of CD ROM for literature search.
- 15) Accessign databases for nucleic acids and proteins.

#### Distribution of marks in University Practical Examination:

1.	Long Experiments	-	15 marks.
2.	Short Experiments	-	10 marks
3.	Viva-voce examination	-	05 marks
4.	Spotting	-	05 marks
5.	Practical record book	-	05 marks
6.	Internal Assessment	-	10 marks
<b>Total</b>		<b>-</b>	<b>50 marks</b>

#### M.Sc PART II (MICROBIOLOGY) EXAMINATION

(Semester –III)

**paper-IX**

#### Molecular biology

- UNIT I : Nucleic Acids :** Importance of nucleic acid in living systems, general composition of nucleic acids, purine and pyrimidine bases, tautomeric forms of bases, reactions of purines and pyrimidines, structure of nucleosides and nucleotides, deoxynucleotides, cyclic nucleotides and polynucleotides. Watson and Crick model for DNA. Different types of DNA and RNA
- UNIT III DNA Replication:**
- i) Enzymes of DNA replication in prokaryotes and eukaryotes, replication mechanisms in prokaryotes, eukaryotes, and phages.
  - ii) DNA repair mechanism
- UNIT-III: a) Genetic recombination:** Mechanism of genetic recombination, Transformation, Transduction, Conjugation and Transposable elements
- b) Genetics and Molecular organization:** Genes concept, genome, Multigene families, Pseudogenes, split genes, overlapping genes, genetic code

- d) **Gene mutation:** Insertion deletion, frame shift and suppressor mutation, chemical and physical agents

**UNIT-IV: Protein Synthesis:**

- a) **Transcription:** RNA polymerases in prokaryotes and eukaryotes, process of transcription, concept of promoters and promoters types, enhancers and silencers and other regulatory elements, post transcriptional processing of tRNA, mRNA and tRNA, transcripts. Post transcriptional modification, spliceosome assisted and self-splicing of RNA transcripts. RNA dependent synthesis of RNA and DNA.
- b) **Translation:** Protein synthesis, Translational process and control of translation, post-translational modification (covalent modification, phosphorylation, glycosylation, mythelation etc. protein targeting and degradation, non-ribosomal polypeptic synthesis Processing of RNA.

**UNITV : Regulation of gene expression:** Gene regulation in prokaryotes - operon concepts (Lac operon and trp, arabinose operon), Negative & Positive Control, Sigma factor, Post translational regulation, etc.

**Gene regulation in eukaryotes-** Regulation at transcriptional and translational level, by gene rearrangement

**PAPER-X  
VIROLOGY**

- UNIT-I:** a) **Introduction to Virology:** Historical aspects: nature of viruses; origin and evolution of viruses, terminology, differentiation with other microorganisms.
- b) **General properties of Viruses:** Morphology, size, host specificity, viral structure, shape, Chemical properties, Susceptibility to physical and chemical agents, Viral Haemagglutination,
- c) **Replication:** Mechanism of virus adsorption and entry into host cell including genome replication, and m-RNA production by animal virus, mechanism of RNA synthesis, mechanism of DNA synthesis, transcription mechanism and post transcriptional processing, translation of virus, proteins, assembly, exit and maturation of progeny virions, multiplication of Bacteriophages.
- d) Viral assay, viral genetics, Nomenclature of viruses.
- UNIT II : Virus-host Interaction:** Epidemiology, pathogenesis, Host response to virus Infections, Laboratory diagnosis of viral infection, Immunoprophylaxis, chemoprophylaxis and chemotherapy of viral diseases.

**Interferons and Antiviral Agents:** Definition, types of interferons; Nomenclature and classification of interferon. Types of inducer, induction of interferon. Antiviral effect of interferon; Molecular basis of antiviral state: Antiviral protein(s) (AVPS): ds RNA dependent pathways and ds RNA independent pathways. Interference not mediated by interferon (intrinsic factors).

**UNIT III : Laboratory Diagnosis of Viral Infections:** Microscopy, Cultivation of Viruses: Animal inoculation, chick embryo and tissue-cultures (MKC, Human Embryonic Kidney cell culture, Human Amnion cell culture). Serology, detection of viral proteins and genetics material

**UNITIV : Structure, Pathogenesis, Laboratory Diagnosis & immunology of viruses:** Pox virus, Herpes viruses, Adenoviruses Picorna viruses,

**UNITV : Structure, Pathogenesis, Laboratory Diagnosis & immunology of viruses:** Orthomyxoviruse, Paramyxoviruses, Arboviruses, Rubella, Arenaviruses, Rabdoviruses, Hepatitis virus. Miscellaneous virus

**PAPER-XI**

**FERMENTATION TECHNOLOGY**

**UNIT-I :** **Bioreactors:** Design and type of fermentors, unit operation and techniques, batch and continuous fermentations, evolution of bio-kinetics constants. Significance of bio-kinetic constants, Computer control of fermentation process.

**UNITII:** a) **Industrial production:** Penicillin, streptomycin, and tetracycline.

b) **Anticancer drug:** interferons, anthracycline, L-asparginases.

Biotechnological application for the production of rare biological molecules, antibiotics, vaccines, steroids, hormones and diagnostic kits

**Unit-III: Food and beverage production.**

a) Cottage & cheddar cheese, Yoghurt and *Dahi*

b) Mycotoxin production

c) Oriental food fermentations: 1) Koji 2) Soya Sauce 3) Miso,

d) Single cell proteins, mycoproteins.

e) Types of different alcoholic beverages and production of whisky.

**UNITIV: Food Technology:**

a) Starter culture for food industries,

- b) Production and preservation of following fermented foods:
- Soya souse fermentation by moulds,
  - Fermented vegetables – Sauerkraut
  - Fermented Meat – Sausages
  - Production and application of Bakers Yeast
  - Application of microbial enzymes in food industries.
- c) Food borne infection and intoxications, bacterial with examples of infective and toxic types: *Clostridium*, *Salmonella*, *Shigella*, *Staphylococcus*, *Compylobacter*, *Listeria*.
- d) **Quality assurance:** Microbiological quality of standard of food, Government regulatory practices and policies. FDA, EPA, HACCP, ISI.

**UNIT-IV: A) Biomass Production :**

- i) **Bacterial biomass- production:** a) *Bacillus megatherium* b) *Acinebacter cerificans*.
- ii) **Fungal biomass production:** *Paecilomyces varioti* by Pekilo process & *Candida utilis* from hydrocarbon.

**B) Prebiotics and probiotics**

- Importance of probiotics
- Sources of Prebiotics
- Probiotics organisms
- Desirable characteristics
- Benefits of probiotics consumption

**PAPER-XII**

**IMMUNOLOGY**

**UNIT-I :** **Basic Immunology-** Anatomic organization of the immune system cell types and organs. Effect of mechanisms involved in specific and nonspecific immune mechanisms. characters. Immune Response- primary, Secondary, Immunological memory.

**UNIT-II** **Antigens, and Immunogenicity**, variation in antigenic Antibody and Immunoglobulins- Structure and functions of IgG, IgA, IgM, IgD, & Ig E., Antigen-Antibody reactions.

**UNIT-III :** **Clinical Immunology** - Complement system; classic and alternate pathways and functions,. Cell mediated immunity. Immunological tolerance and Immunosuppression. Tumors Immunological. Autoimmunity and Autoimmune diseases,

**UNIT-IV:** A) Hypersensitivity, Immune deficiency diseases, MHC class Molecules.

- B) Conventional vaccines, peptide vaccine, subunit vaccine, genetically engineered vaccines, production and application of lymphokines. Antibody diversity, Immunogenetics.

**UNIT-V : Immunobiotechnology & Hybridoma Technology:**

Immunization of animals, isolation of stimulated spleen cells, myeloma cell lines used as fusion partners, fusion method, detection and application of monoclonal antibodies,

**PRACTICAL-V**

**APPLIED MICROBIOLOGY**

**a) Applied microbiology**

- Isolation of antibiotic producing organism from soil.
- Microbiological assay of antibiotics and purification by ion-exchange resin.
- Determination of k<sub>la</sub> for fermenter.
- Preparation of yoghurt, koji, cheese. Idli
- Preparation of Flavor and aroma.
- Solid state fermentation of some product.
- Microbiological assay of amino acids .
- Microbiological assay of vitamins.

**c) Plant tissue culture:**

- Preparation of media for plant cell culture.
- Callus from explants.
- Haploid cell culture.
- Proto-plast culture.
- Educational tour and submission of report.

**PRACTICAL-II**

**IMMUNOLOGY AND CLINICAL MICROBIOLOGY**

**1.** Diagnostic methods for isolation and Identification of pathogenic microorganisms from the following specimens:

- (a) Blood (b) Urine (c) Cerebrospinal fluid (d) Throat (Swabs)  
(e) Sputum (f) faeces (g) Pus and wound (infection) fluid.

**2. Isolation and identification of following pathogenic bacteria:**

- (a) *Staphylococcus aureus* (b) *Streptococcus pyogenic*  
(c) *Streptococcus pneumoniae* (d) *Salmonella typhi* and paratyphi A.B.C. (e) *Shigella* Species (f) *Escherichia coli* (g) *Proteus vulgaris*  
(h) *Pseudomonas aeruginosa* (i) *Vibrio cholera* (j) *Mycobacterium tuberculosis* (k) *Clostridium titanicae*

**3. Serology:**

- a) VDRL Test b) RPR test c) Kahn test d) Widal test  
e) C-Reactive protein f) Anti streptomycin-o g) R.A. Factor

- h) ELISA test i) Surface visual B-96 test (ELISA)  
j) Latex agglutination test (pregnancy test)
4. **Diagnostic Immunology:**  
a) Double diffusion methods of ouchterolony  
b) immunoelectrophoresis  
c) Quantitative determination of plasma protein by immunoelectrophoresis.  
d) Single radial immunodiffusion.  
e) Estimation of antigen-antibody response by immunodiffusion technique.  
f) Estimation of antigen- antibody response by immunoelectrophoresis.
5. **Preparation of monoclonal antibodies.**
6. **Hematology:**  
a) Estimation of HB, b) PCV c) Blood cell counts W.B.C. & R.B.C.  
d) ESR e) blood smear examination f) bleeding time g) clotting time  
h) prothrombin time i) prothrombine determination j) Lab. diagnosis of leukaemias.
7. **Study of medical Parasitology:**  
a) *E. histolytica* b) *Trypanosomes*  
c) Leishmania and d) Plasmodium
8. **Stool Examination for:**  
a) Ova, cysts of intestinal parasite blood cell and pus cells b) Occult blood, c) Characteristics of the stool in amoebic and bacillary dysentery.
9. **Antibiotic and chemotherapeutic agents:**  
a) Antibiotic sensitivity test.  
b) Assay of antibiotic level in the body fluids.
11. **Routine examination of urine.**
12. **Student seminar and submission of report.**

**Distribution of marks in University Practical Examination:**

1. Long Experiments (At least two)	-	15 marks.
2. Short Experiments	-	10 marks
3. Viva-voce examination	-	05 marks
4. Spotting	-	05 marks
5. Practical record book	-	05 marks
6. Internal Assessment	-	10 marks
<b>Total</b>	-	<b>50 marks</b>

**M.Sc Part II (Semester IV)**

**Paper XIII**

**BIOTECHNOLOGY**

**Unit-I : Genetic Engineering**

- a) **Enzymes used in recombinant DNA technology:** Endonucleases, ligases, Enzymes to modify DNA molecules.  
b) **Vectors:** Plasmids, plant vector, bacteriophages, cosmids, phagmides, animal viruses, plants viruses, special vectors.

**UNIT II : Genes cloning in prokaryotes & Eukaryotes:** Isolation of gene, Methods of gene transfer, Selection and screening of recombinant DNA, nucleic acid hybridization and clot curves, southern, northern and western blotting techniques, dot and slot blots, colony hybridization.

**UNIII : Cloning strategies:**

- a) Cloning from m-RNA and genomic DNA, synthesis of gene, gene probes, gene banks, gene libraries, mapping of gene, DNA sequencing, RFLP, DNA finger printing, site direct mutagenesis.  
b) Polymerase chain reaction & gene amplification.

**Unit-IV : Plant Biotechnology:**

- a) Culture media and plant cell culture  
b) Tissue culture, micropropagation and somaclonal variation  
c) Production and use of haploid cell culture  
d) Protoplast culture, regeneration and somatic hybridization  
e) Gene transfer method in plants, transgenic plants and animals.

**Unit-V : Application of Biotechnology:**

- a) Application in agriculture, plants and animal improvement.  
b) Enzyme biotechnology  
c) Protein engineering, immunotoxins and drug designing  
d) Metabolic engineering for over production of metabolites.  
e) Use of microbes in industry and agriculture  
f) Application to medical sciences, gene therapy, genetic counseling, diagnosis of diseases and phenomenon of ageing.  
g) Control of environmental pollution, recovery of minerals and restoration of degraded lands

**PAPER-XIV****CLINICAL VIROLOGY**

- UNIT-I :** **Plant Viruses:** Classification, life cycle and replication of tobacco mosaic virus (TMV), PVX, PVY, CMV, TSWV, CaMV, Cynophages, Mycoviruses
- UNIT II :** **Bacterial Viruses:** Life cycle, Structure and replication of following RNA and DNA phages: Ox 174 phage, T4 phage; Lambda phage. (Lyric and glycogenic Cycle); Ft phage; MS2, f2, QB phages and Mud phage and O6 phage.
- UNIT III: a) Oncogenic Viruses (Tumor Viruses) :** Classification of viruses characteristics of virus transformed cell or tumor cell.
- i) DNA - Containing Tumor Viruses :
- ii) RNA - Containing Tumor Viruses : Retroviruses (oncornaviruses) .
- UNITIV: a) AIDS viruses: Retro viruses, HIV**
- UNIT V: Viroids and Prions.**

**PAPER-XV****MICROBIAL TECHNOLOGY**

- Unit-I :** Isolation and screening of microorganisms, maintains of isolates/ strains, Inoculum developments, sterilization, strain improvement, process development, Downstream processing, In situ recovery of products. General scale up procedure
- Solid-state fermentations
- Manufacturing cost estimation
- Principal and general consideration in down stream processing.
- UNIT-II: a) Fermentation of acids:** Aspartic acid, L glutamic acid and Gluconic acid.
- b) Modern trends in Microbial Productions:** Bioplastic (PHB, PHA) Biopolymer (Dextran, alginates, xanthan, Pullulan)
- UNIT II Fermentation Of enzymes and Amino acids:** Amylase, Protease. Riboflavin, cyanocobalamine,
- UNIT III :** **Enzyme biotechnology:** Immobilization of enzymes - (glucose -isomerase) Methods, bioreactors and application in industry. Enzyme electro catalysis. Biosensors- Bioelectodes, Optrons, Immunological biosensors.
- UNIT-IV :** **Fuel Biotechnology:** Biofuels, Energy crops, Biogas, Bioethanol, Biobutanol, Biodiesel, Biohydrogen.
- UNIT V: Biofertilizers and Biopesticides.**

- a) Basic concept: PSM, N2 Fixer, S-solubilizers etc, K-solubilizers
- b) Biomass production
- c) Formulation (Carrier based, dried, liquid, and mixed inoculum)
- d) Application methods
- e) Inoculation quantity concept.
- f) Biopesticides: Bacterial, fungal, viral etc.
- g) Biocontrol mechanism,
- h) Preparation and application of Biopesticides

**PAPER-XVI****MEDICAL MICROBIOLOGY**

- Unit-I :** **Pathogenic bacteria and laboratory diagnosis:** *Staphylococci, Streptococci including pneumococci, Mycobacterium tuberculosis* and *M. leprea*
- UNIT II Pathogenic bacteria and laboratory diagnosis:** *Escherichia, Klebsiella, Proteus, Salmonella, Shigella, Pseudomonas, Bordetella, Haemophilus, Vibrio, Campylobacter, Treponema, Borrelia, Leptospira, Corynebacteria, Mycoplasma* and *Rickettsia*.
- Unit-III Pathogenic fungi and their laboratory diagnosis:** *Microsporium, Trichophyton, Epidermophyton, Candida albican, Cryptococcus neoformans, Blastomyces dermatitidis* and *Histoplasma capsulatum*.
- UNITIV Parasites and their laboratory diagnosis:** *Entamoeba histolytica, Leishmania donovani, Trypanosoma spp., Plasmodia species, Taenia saginata, Taenia solium Echinococcus granulosus, Hymenolepsis nana, Ascaris lumbricoides, Enterobius vermicularis* and *Wuchereria bancrofti*.
- Unit V :** **Clinical Microbiology:** Normal microbial flora of human body, sore throat and pneumonia, UTI, Diarrhaial diseases, Meningitis, Bacterimia, septicimia, Infective Endocarditis, PUO, STD, Hospital acquired infections, , Prophalalytic imuunization, antimicrobial therapy, Antimicrobial sensitivity testung, Hospital waste management, Vechicals and vectors.

**PRACTICAL-VII****APPLIED MICROBIOLOGY AND BIOTECHNOLOGY****RECOMBINANT DNA TECHNOLOGY**

- 1) Agarose gel Electrophoresis
- 2) Restriction Digestion of DNA

- 3) DNA Ligation
- 4) DNA Molecular size Determination
- 5) DNA Fingerprinting
- 6) Southern hybridization
- 7) Restriction Mapping
- 8) In vitro Transcription
- 9) Southern Blotting
- 10) Northern Blotting
- 11) Plasmid preparation
- 12) Genomic DNA isolation.
- 13) Gene Cloning
- 14) Bacterial Gene expression.
- 15) Bacterial Transformation
- 16) Bacterial Conjugation
- 17) Bacterial Transduction
- 18) Whole Blood DNA extraction.
- 19) Educational tour and submission of report.

#### Project work (Marks 50)

##### Distribution of marks in University Practical Examination:

1. Long Experiments (At least two)	-	15 marks.
2. Short Experiments	-	10 marks.
3. Viva-voce examination	-	05 marks
4. Spotting	-	05 marks
5. Practical record book	-	05 marks
6. Internal Assessment	-	10 marks
<b>Total</b>	-	<b>50 marks</b>

##### Distribution of marks in Project work Examination:

1. Valuation project	-	40 marks.
1. Internal Assessment	-	10 marks
<b>Total</b>	-	<b>marks</b>

##### Project Work -

##### Examination of Project Work :

1. The examination should be held at the centres of practical examination.
2. There shall be panel of examiners including Head of the department and the Supervisor of the Student.
3. There should be at least 2 to 3 external examiners for a batch of up to 10 Students or 3 to 5 external examiners for a batch of more than 10 Students.

4. The Students should submit the project reporty within 20 days after the last/final theory paper in University examination.
5. The date of Viva-voce examination on project work should be within the 30 days after the completion of theory examination

##### Distribution of marks in Project work examination:

1. Evaluation of Project		20 marks
2. Viva--voce (Jointely by internal and external examiners)		20 martks
3. Internal Assessment		10 marks
<b>Total :</b>		<b>50 marks</b>

##### Books recommended for M.Sc. Part-I & Part-II (Microbiology)

1. Biophysical Chemistry - Upadhyay & Nath (Himalaya Pub.)
2. Practical Biochemistry - Plummer (TMH Pub.)
3. Principal of Biochemistry - Lehninger (CBS Pub.)
4. Practical Biochemistry - Jayraman (Wiley Estern Pub.)
5. Physical Biochemistry - Morrison (Oxford)
6. Enzyme - Dixon &. Webb
7. Fundamentals of Enzymology - Lewis (Oxford)
8. Bacterial metabolism - A.H. Rose
9. Biochemistry - West & Toad
10. Out line of Biochemistry - Corn & Stump. (Wiley Eastern Pub.)
11. Soil Microbiology - Alexander (Wiley Eastern Pub.)
12. Genes VIII - Lewin (Oxford)
13. Element of Biotechnology - P.K. Gupta. (Rastogi Pub.)
14. Fundamentals of Biotechnology - Purohit & Mathur (Agro Bot. Pub.)
15. Essentials of molecular biology - Freifelder D. (Narosa Pub.)
16. A textbook of biotechnology - Duby (S. Chand Pub.)
17. Molecular Biology - Freifelder D. (Narosa Pub.)
18. Microbial Genetics - Freifelder D. (Narosa Pub.)
19. Text Book of Molecular Biology - Shastry & Other (Macmillan)
20. Hand Book of Tissue Culture (ICAR Pub.)
21. A textbook of Biotechnology - H.D. Kumar (E.W. pub.)
22. Basic Biotechnology Rev. Iganacimuthu (TMH Pub.)
23. Plant viruses - Mandahar (S. Chand & Co.)
24. Microbiology Lewis. (Harper)
25. Microbiology - Fundamentals & Application - Purohit. (Agro Botanical Pub.)
26. Industrial Microbiology - Casida (Wiley Eastern pub.)
27. Press Scott and Dunn's Industrial Microbiology.

28. Microbiology - Anantnarayan & Panikar (Orient Longman)
29. A text book of Microbiology, — P. Chakraborty (Central Pub.)
30. Medical Microbiology - Ichhapunani & Bhatia (J.P. Brothers)
31. Essential of Medical Mycology - Evans & Genitals (Churchill and Livingston)
32. Genetics by Strickbeger (Prentice Hall)
33. A short textbook of recombinant DNA technology Watson. (Black Well)
34. Molecular Biotechnology - Prime Rose - (Black Well.)
35. Immunology by Shetty - (Wiley Eastern Pub.)
36. Molecular biology of genes. Watson - (Begamin Cumming))
37. Recombinant DNA technology - Rodriguez (Begamin Cumming)
38. Advances in molecular genetics. Puhlar. (Begamin Cumming)
39. Molecular cloning - A lab manual. (Cold spring harbor lab pub.)
40. Concept of molecular biology - Rastogi (Wiley Eastern Pub.)
41. Genetic Engineering - Sandhy Mitra (Macmillan)
42. Elementary Microbiology Vol. I Vol. II (Fundamental of microbiology and microbial world) Ed. by. H.A. Modi. (Akta Prakashan)
43. Applied microbiology. Ed. by H.A. Modi. (Akta Prakashan)
44. Environmental Microbiology. Ed. by H.A. Modi (Akta Prakashan)
45. Fundamentals of Dairy Microbiology by J.B. Prajapati (Akta Prakashan)
46. Bio-Fertilizer. By Vyas & Modi (Akta Prakashan)
47. Biochemistry. By D. Das (Academic Pub.)
48. Biophysics & Biophysical Chemistry. By D. Das. (Academic Pub.)
49. Modern Immunology. By A. Das Gupta (Jaypee Pub.)
50. A textbook of microbiology by P. Chakraborty (New Central Book Agency)
51. Principal of gene manipulation by Old & Prim Rose (black well pub.)
52. Agricultural microbiology by Rangaswami & Bagyaraj (PHI)
53. An introduction to recombinant DNA by A.E.H. Emery (ELBS)
54. Concepts in Biotechnology by D. Bakasubramuniam and other (University Press.)
55. Introduction to genetics Engineering by D.S.T Nicholl (Cambridge)
56. Genetics by P.K. Gupta (Rastogi Pub.)
57. Genetics by Sandhya Mitra (TMH)
58. Applied plant biotechnology by Iganacimuthu (TMH)
59. Immunodiagnosis S.C. Rastogi (Wiley Eastern Pub.)
60. Immunology by Roitt. (Black well)

61. A textbook of Microbiology. R.C.Dubey and D.K.Maheshewari. (S.Chand & Company)
62. Genetics - A.V.S.S. Sambamurty (Narosa Pub.)
63. Concept of Molecular Biology. P.S.Varma & V.K. Agrawal. (S.Chand & Company)
64. General Microbiology S.B. Sullia and S. Shantharam. (Oxford & IBH)
65. Modern Concept of Biotechnology. H.D.Kumar (Vikas Pub.)
66. Fundamentals of Enzymology - Price and Steven (Oxford Sci.Pub.)
67. Gene VII - Lewis (Oxford Science Publication)
68. Molecular Cell Biology, Berk, Lipursky, Baltimore, Darnell and Matsudaira (W.H. Freeman and Company)
69. Biotechnology - Rhem and Reead
70. Standard method s of Biochemical analysis - S.R. Thimmaiah (Kalyani Publisher).
71. Laboratory Manual of Bacterial Genetics - Institute of Microbial Technology - Chandigarh.
72. A textbook of Industrial Microbiology - WulfCrueger and Annekiese Cruger (Panima Publishing Corporation)
73. An Introduction to electrophoresis - K. Anbalgan (The Electrophoresis Institute, Salem Dist.S. India.)
74. Waste water microbiology - Gabrian Bitton (John Wiley & Sons)
75. Environmental Microbiology - Ralph Mitchell (John Wiley and Sons).
76. Microbial Biotechnology - Fundamentals of applied Microbiology - Alexander N. Glazer, and Hiroshi Nikoidu (W.H. Freeman and Company)
77. Gene structure and expression - John D. Hawkins (Cambridge University Press)
78. Biotechnology - John G. Smith, (Cambridge University Press)
79. Plant Biotechnology - S. Ignacimuthu S.J. (Oxford and IBH, New Delhi)
80. Advanced molecular biology - R.M.Twyman (Viva book Pvt.Ltd.)
81. Introductory Microbiology - J.Heritage, E.G.V. Evans and R.A.Killington (Cambridge University Press)
82. General Microbiology - Schiegel (Cambridge University Press)
83. Gene Structure - Hawkins (Cambridge University Press)
84. Modern Concepts of Biotechnology - H.D.Kumar, (Vikas Publishing Pvt.Ltd.)
85. A textbook of Microbiology - R.C.Dubey and D.K.Maheshewari (S.Chand & Company)

86. Biotechnology - Applications and Research - Edited by Paul Cheremisinoff and Robert Ouellete (Technomic Pub.Co.Inc.)
87. Basic and Clinical Immunology - Daniel Stites, Abba Terr & Tristram Parslow (Prentice Hall International INC)
88. A Text Book of Biochemistry with Clinical correlation - Edited by Thomas Devlin (John Wiley and Sons, INC).
89. Microbiology Laboratory - Fundamentals and Application, George Wistreich (Prentice Hall)
90. Microbiology - A Laboratory Manual - James Cappucino and Natalic Sherman (The Benjamin/ Cummings Pub.Co.Inc.)
91. Foundations in Microbiology - Kathleen Talaro & Arthur Talaro (Wm.C. Brown Publishers)
92. Principles of Microbiology - Ronald Atlas Mosby.
93. Fundamentals of Microbiology - Alcamo (Benjamin / Cummings Pub.Co.Inc.)
94. Sale and Molecular Biology - Concepts and experiments - Gerald Karp (John Wiley and Sons, INC).
95. Cellular and Molecular Immunology - Abul Abbas, Andrew Lichman & Jordan Pober (W.B.Saunders Co.)
96. Biochemistry-Zubay (Wm C.Brown Publishers)
97. Life-An Introduction to Biology - Beck, Liem & Simpson (Harper Collins Publishers)
98. Genetics - A. V.S.S. Sambamurthy (Narosa Publication)
99. Water Pollution - V.P.Kudesia, (Pragati Prakashan Meerut)
100. Physicochemical Examination of Water, Sewage and Industrial waste - N. Maniwasakam (Pragati Prakashan, Meerut)
101. Textbook of Biochemistry - O.P.Agrawal, G.R.Agrawal (Goel Publishing House, Meerut)
102. Textbook of Medical Mycology - Jagdish Chander (Interprint, New Delhi)
103. An introduction to Plant tissue and Cell culture - N.C.Kumar (Emkay Publication Delhi)
104. Short Protocols in Molecular Biology - Edited by Ausubel, Brent, Kingston, Moore, Seidman, Smith and Struhl (John Wiley and Sons)
105. Molecular Cell Biology - Darnell, Lodish and Baltimore, (Scientific American Books)
106. Technological Applications of Biocatalysts - Published on behalf of Open University and University of Greenwich (Butterworth-Heinemann).
107. Microbiology-Principle and Explorations - J.G.Black (John Wiley and Sons)

108. Techniques for engineering Genes - Published on behalf of Open University and University of Greenwich (Butterworth-Heinemann).
109. Biotechnological Innovations in Energy and Environmental management - Published on behalf of Open University and University of Greenwich (Butterworth-Heinemann).
110. Medical Microbiology - Mims, Playfair, Roitt, Wakelin and Williams (Mosby)
111. Principles of Enzymology for the Food Sciences (John Whitaker, Marcel Dekker, Inc.)
112. Biostatistics - A Foundation for analysis in Health Sciences - W.D.Daniels, John wiley and Sons.
113. Basic Statistics - C, Dunn
114. How Computers Works - Ron White, Techmedia.
115. How the Internet works - Preston Gralla, Techmedia.
116. Bioinformatics - 1998 - Baxevanis
117. Bioinformatics - 2000 - Haggins & Taylor OUP.
118. Fundamentals Biostatistics- Sadguru Prakash, Emkay Publication, New Delhi.
119. Bioinformatics for Beginners - Dr.K.Mani & N.Vijayraj (Kalai Kathir Achchagani Pub. Coimbatore)
120. Instant Notes - Bioinformatics - West head, Parish and Twyman (Viva Publication) New Delhi.
121. Schaum's Outlines - Biochemistry, Kuchel & Ralston (TMH Edition)
122. Schaum's outlines - Microbiology (TMH Edition)
123. Schaum's outlines - Molecular and cell Biology (TMH Edition)
124. Principles of Genetics - R.H.Tamarin (TMH Edition)
125. Biotechnology DNA - Protein A Laboratory project in molecular Biology. Thiel, Bissen & Lyons (TMH Edition)

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# INDEX

## M.Sc.Part-I & Part-II (Semester I to IV) Examinations in Microbiology (Prospectus No.2009128)

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Sr.No.	Paper	Page Nos.
1.	Special Note	1
2.	Ordinance No. 4 of 2008	3
<b>M.Sc. Part-I Semester I</b>		
3.	I Microbial Techniques	2
4.	II Microbial Enzymology	2
5.	III Microbial Physiology and Photosynthesis	3
6.	IV Environmental Microbiology	4
<b>M.Sc. Part-I Semester-II :</b>		
7.	V Biostatistics, Bioinformatics and Computer Applications	6
8.	VI Enzyme Technology	8
9.	VII Microbial Metabolism	9
10.	VIII Environmental Microbiology and Extremophiles	10
<b>M.Sc. Part-II Semester-III :</b>		
11.	IX Molecular Biology	12
12.	X Virology	13
13.	XI Fermentation Technology	14
14.	XII Immunology	15
<b>M.Sc. Part-II Semester-IV :</b>		
15.	XIII Biotechnology	18
16.	XIV Clinical Virology	19
17.	XV Microbial Technology	19
18.	XVI Medical Microbiology	20

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