

MANGALORE UNIVERSITY

Microbiology  
Ph.D.

Papers	Particulars	Hours of Instruction per week	Duration of Examination (hrs)	Marks		Credits
				IA	Theory	Total
Paper 1	Research Methodology	4	3	30	70	100
Paper 2	Theoretical Foundations	4	3	30	70	100
Paper 3	Recent Developments	4	3	30	70	100
Paper 4	Reviewing of Literature and Planning of the Proposed Research Work with a Tentative Title	16				200
	Total					200
						20 Credits

*Approved*  
*[Signature]*

*[Signature]*  
*(K S Jagannathan)*  
*[Signature]*  
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MANGALORE UNIVERSITY  
PATTERN OF QUESTION PAPER OF INTERNAL ASSESSMENT EXAMINATION  
FOR PH.D COURSE IN MICROBIOLOGY

EFFECTIVE FROM 2011-2012

Time: 1½ Hours

Max. Marks: 30

5x6= 30

Answer any SIX of the following

- 1.
- 2.
- 3.
- 4.
- 5.
- 6.
- 7.
- 8.



Note: The Internal Assessment Test to be conducted after completion of Two Months of the semester.

Approved  
D. S. Jagan

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(K. S. Jagan)

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MANGALORE UNIVERSITY

PATTERN OF QUESTION PAPER OF UNIVERSITY EXAMINATION  
FOR P.H.D COURSE IN MICROBIOLOGY

EFFECTIVE FROM 2011-2012

Time: 3 Hours

Max. Marks: 70

PART - A

I. Answer any SIX of the following

5x6= 30

- 1.
- 2.
- 3.
- 4.
- 5.
- 6.
- 7.
- 8.



PART - B

II. Answer any FOUR of the following

10x4= 40

- 9.
- 10.
- 11.
- 12.
- 13.
- 14.

Approved  
KS Jagannathan

KS Jagannathan  
Head of Department  
Microbiology

MANGALORE UNIVERSITY

SUBJECT: MICROBIOLOGY



SYLLABUS, SCHEME, PATTERN OF QUESTION PAPERS  
DOCTOR OF PHILOSOPHY (Ph.D) PROGRAMME

Paper I  
**RESEARCH METHODOLOGY**

100 marks

4 hrs / week

Total hrs 60

Testing of hypothesis - refinement of experiment, field / lab technique - design, sample size, collection, compilation, analysis, interpretation of data and drawing conclusions, literature retrieval, citation methods, format in writing research paper or dissertation, Research Hypothesis, research problem, its importance, background, data collection, preliminary observations, methods, analysis, recording the data and presentation of data.

Arrhenius, Lowry - Bronsted and Lewis concepts, preparation of molar solution, normal solutions, buffers, amphoteric nature, mole concept. Amino acids as buffering electrophiles, nucleophiles agents, Handerson-Hessell- batch equation.

Microscopy - Fluorescent, Transmission and Scanning. Microscopic techniques - Preparation of sample and their applications. X-ray diffraction technique. Principle, methods and applications of various types of Chromatography, HPLC, GLC, Dialysis and Precipitation technique, Ultra centrifugation, Electrophoresis, Electro focussing, principle, methods and applications. Autoradiography, Radioimmunoassay, ELISA, Blotting techniques- Southern, Northern, Western.

Standard deviation, Theory of probability, student t test, analysis of variance, graphical representation of data, principles of computing. Measures of central tendencies: Mean median and mode, measures of dispersion: range, CV & SE, scatter plot, simple correlation and regression, multiple correlations, construction of frequency table.

Statistical packages: MS EXCEL, SPSS, MINITAB, PAST packages, application of biostatistics and their use, computer application in biological research, sources of information; Journals, Books, Biological abstracts Reviews, Databases, Search engines, INFLIBNET, Pub med, Science Direct, e - journals, Bibliography, Methods of writing the research findings, Components of dissertations, Structure of research article. Presentation of research findings, Preparation of Power point presentation, Poster presentation.

Introduction to bioinformatics, History, biological sequence, pattern recognition and prediction. Sequence analysis, homology and analogy. Brief account on search engines and biology workbench.

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## Theoretical Foundations

100 marks

4 hrs / week

Total hrs 60

Microbiological relevance of environmental biology and human affairs. Species interaction, Pollution - Air, Soil and Water, Biodiversity and its importance. Bioprospecting of microorganisms which are difficult to cultivate, maintenance of genetic material and genetic library, conventional and molecular methods of studying microbial biodiversity. Microbial culture collection centres. Mycorrhizae and their uses. Biodiversity of soil, air and water microorganisms. General characters of Algae, Blue Green algae, morphology, ultra structure, distribution, economic importance of algae. Microbes in extreme environment, microbes in bio deterioration, bio remediation. Biodiversity act, 2002.

Classification, structure and function of proteins, carbohydrates and lipids. Metabolism of carbohydrates; Glycolysis, Glycogen metabolism and TCA cycle, Pentose phosphate pathway, Oxidative phosphorylation, Utilization, Transport and storage of lipids, lipoproteins. Metabolism of amino acids and Nucleic acids. Enzymes; kinetics, inhibition and regulation of enzyme catalysed reactions. Microbial defence agents, sensing systems. Basic features of the genetic code, protein synthesis, Molecular Chaperons, nucleic acids as genetic information carriers; DNA structure, DNA replication, general principles, structural features of RNA (rRNA, tRNA, mRNA). Gene regulation during stress. *E. coli*: Lac operon; positive regulation- *E. coli* Lac operon. Plasmids - P factors and their role in genetic analysis, mutation and mutagenesis, gene mutation, types of mutation, mutagenic repair system, genetic recombination in bacteria, heterosexuality in fungi, heterokaryosis, heteroploidy and parasexuality and their application. Role of sex hormones in fungi. Molecular biology of bioluminescence.

Processing of food products- milk products, vegetable related food products, fruit products, animal products, spoilage in food products, detection of spoilage using advanced molecular techniques, detection of food borne pathogens, preservation of food products. Development of biosensors to detect food contamination and environmental pollution. Concept of Probiotics and applications of new tools of biotechnology for quality food production. Microorganisms and proteins used in Probiotics. Lactic acid bacteria as live vaccine. Biofermentor, production of wine, beer, lactic acid, acetic acid, citric acid, antibiotics, enzymes, vitamins and single cell proteins. Bioplastics and biopolymers- its role in environmental monitoring, microorganisms involved in degradation of environmental hazardous chemicals, pesticides, plastics etc. Biofertilizers, genetically engineering of microbes for enhanced pesticide degradation, Mechanism of pesticide degradation by microbes, Yeast for food product its technology, classification, genetics, strain improvement for brewing, baking and distilleries. Role of microorganisms in soil fertility. Bioremediation of polluted soils, biological control. Importance of medical microbiology, conventional and advanced methodology involved, identification of pathogens using molecular methods. Pathogenicity, antimicrobial compounds from different source, Cancer biology- methods involved in study, detection and prevention, AIDS- its treatment and control. Microbial toxins- exo and endo toxins, differential media for pathogens, biochemical tests and rapid diagnostic kits, opportunistic and true pathogens, toxigenicity and invasiveness.

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PAPER III

RECENT DEVELOPMENTS

SPECIALIZATION: MICROBIAL DIVERSITY

100 marks

4 hrs / week

Total hrs 60

Archae bacteria, its morphology and ultra structure, morphological types, nutrition and recombination. Emerging Eubacteria Isolation, Identification both by conventional and molecular methods, Screening of these novel species for commercial products, Construction of genetic library, Preservations of bacterial cultures. Use of bacteria in biocontrol and translocation, bacterial leaching.

Emerging bacterial diseases through Soil, Water, Air, Food, Animals etc, isolation, cultivation and identification of pathogens, toxicity and toxins, Antigenic structures, Homogeneity, treatment and its control, Antibiotics, Vaccines, rDNA technology in treatment of diseases and strain improvement for commercial products, Probiotics and its health benefits.

Organization of bacterial genomes, repetitive DNA, bacterial plasmids, cosmids, F-factors, transposons, Introns and Exons, overlapping genes, Genetic codes, Genetic analysis-complementation analysis genetic mapping, deletion mapping, cis trans test, Mutation and mutagenesis, mutagenic repair system, site directed mutagenesis, genetic recombination in bacteria. Phages animal and bacterial viruses invented in recently and their life cycles, their pathogenesis, viral systematics

Historical development and classification of bacteriophages. Physiology, biochemistry, enzymology and molecular biology of phagebacterial interactions. T7, T4, P1,  $\lambda$  phage etc, life cycle and their uses in microbial genetics with reference to rII locus, viral vectors. Embryo and tissue culture techniques and other advanced recent techniques.

Morphology, distribution of fungi, Plant, animal and human pathogens, structure, its life cycle, Pathogenicity and symptoms, treatment and control. Use of fungi in biocontrol, bioremediation, and biotechnology, Bio pigments, economic importance and uses in industrial biotechnology. Marine fungi and its economic importance. New Algal species, Nutrition and reproduction, Algal cultivation, eutrophication, diseases and problems associated with algae, Lichens, algae as indicator of pollution, Algal culturing and cultivation. Use of algae in biocontrol, bioremediation, and biotechnology. Marine and fresh water algae, their diversity, bioprospecting and its economic importance

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## SPECIALIZATION;

## BIOINFORMATICS

100 marks

4 hrs / week

Total hrs 60

Nucleic acids - DNA and RNA and its type, replication, genetic recombination, genetic code, protein synthesis, regulation of gene expression- operon concepts, attenuation and anti termination, post transcriptional and translational modification, environmental regulation of gene expression. Gene action during oogenesis, spermatogenesis, molecular and cellular biology of fertilization, genetic basis of differentiation- nuclear cytoplasmic interaction during development and molecular aspects of pattern formation.

Human molecular genetics: genetic linkage and gene mapping, genetic mapping of human chromosomes, human gene sequencing, human gene therapy. Definition, aim and objects of rDNA technology, restriction modification systems, restriction mapping, enzymes, vectors and tools involved in genetic engineering, DNA amplification, technique involved- DNA finger printing, DNA foot printing, Blotting techniques, hybridization techniques, different PCR techniques, analysis of products, FISH, RFLP, RAPD, autoradiography and its application etc. identification of right clones- direct screening, hybridization technique, screening using probes, biosafety and ethical issues related to cloning.

Genetic engineering of micro organisms decoding genetic information, gene expression in prokaryotes, directed mutagenesis and protein engineering, molecular diagnostics- immunological diagnostic procedures, DNA diagnostic procedures, therapeutic agents- pharmaceuticals, enzymes, monoclonal antibodies, nucleic acids etc, commercial products- restriction endonucleases small biological molecules, biopolymers, artificial miRNA (Micro RNA)- a potential tool for gene discovery, etc. genetic engineering of biodegradable pathways and biodegrading microbes.

Genetic engineering of plants modern tools and methods used for gene transfer to plants, development of insect- pathogen- herbicide resistant plants, genetic manipulation of flower pigmentation, modification of plant nutritional content, food plant taste and appearance, plants as bioreactors, edible vaccines. Genetic engineering of animals modern tools and methods used for gene transfer to animals, development of transgenic animals and their application as models for studying diseases, as test system etc. Regulating and monitoring biotechnological products and GMOs

Bioinformatics for study of science, Use of bioinformatics tools in molecular diversity- databases used in bioinformatics- Nucleotides, Proteins, Carbohydrates etc, FAST, BLAST, RAS mol programmes, Proteomics, Genomics, Phylogenetic analysis, drug designing, mutation study and its application in molecular diversity using bioinformatics tools, Microarray techniques. Bioinformatics for nanotechnology, Application of bioinformatics in Microbial biodiversity, food, agricultural, environmental and medical microbiology. Bioinformatics for gene mapping, identification of microbes- tools involved. Computational approach for gene prediction. Algorithmically identifying stretches of sequence, Methods involved- ab-initio and homology based/extrinsic approach- Insilico. Gene prediction in prokaryotes, prediction in eukaryotes. Genefinder- hidden Markov models (HMM), GLIMMER, GeneMark, GENESCAN, GRIAL application of genefinders.

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SPECIALIZATION:  
**FOOD, AGRICULTURAL  
AND  
ENVIRONMENTAL MICROBIOLOGY**

100 marks

4 hrs / week

Total hrs 60

Food as a substrate for Microorganisms. Importance of food microbiology. Molds, Yeasts and Bacteria. Factors influencing the growth of microbes in food- extrinsic and intrinsic factors. Nutritive aspects of food constituents- Quality factors in foods- appearance, texture, flavour, additional quality, quality standards. Determination of microorganisms or the products in food. Food deterioration and its control; Shelf life, Major causes of deterioration principles of food preservation, control organisms, enzymes and other factors. Methods of Preservation- High temperatures, low temperature, Dehydration, Irradiation, Chemical preservatives and others. Food Fermentation- Fermented vegetables, Sausage, Vinegar, Cocoa Bread, Ensilage, Oriental fermented foods, genetically engineered foods, Single Cell Protein.

Nanotechnology in food - Nano foods - cultivation, production, processing and packaging. Use of nano particles and its technology in detection of food borne pathogens. Methodology used in detection of heavy metals, hazardous chemicals and other contamination. Nanoscale control of food molecules in modification of macroscale characteristics of food. Engineered nanomaterials in food microbiology.

Microbiology of Milk - Handling and processing, Microbial contamination and preservation of milk. Biochemical activity of milk. Starter cultures Milk borne infections, Fermented milk and Dairy products- Butter milk, sour cream, yoghurt, cheese, butter and their quality standards. Concepts in quality management of milk and milk products. Food Borne Infection and Intoxication- Bacterial and non bacterial, Microbial indicators of food safety and quality, principles of quality control. Microbiological safety of food- HACCP, Government regulation of food and Nutrition Labelling.

Microbial Growth Kinetics - C/N ratio, C/P ratio, kinetics of batch and continuous fermentation, effect of environmental conditions on microbial growth, control of microbial growth. Production Media: Characteristics and screening of ideal production medium, sterilization. Bioreactors: CSTB, Airlift bioreactors, continuous flow bioreactors, Koji bioreactors and immobilized cell bioreactors. Industrial Microorganisms- Isolation of industrially important microorganisms: screening technique- primary, secondary, strain development, preservation of microorganisms. Strain improvement: The random, empirical approach, recombination, rDNA technology, protoplast fusion, mutation. Nutrition: Macronutrients, minor elements, trace elements.

Computer control of fermentation processes - Computer software and hardware's, applications in fermentation technology, automation of microbiological assay, advance fermentation control options. Industrially important products- Antibiotics, organic acids, enzymes, solvents, amino acids, vitamins, SCP, microbial insecticides, fermented foods, fuels and industrial chemicals, health care products. Algal food technology, Fermentative metabolism by development of bioprocessing technology, Processing and production of recombinant

Flow and chemostat cultures, Fed-Batch and mixed cultures, Scale-up principles, Down Stream processing etc, Biopreservatives.

Soil Microflora- Number, size, occurrence, distribution. Interaction and significance. Factors influencing soil population, organic matter decomposition in soil. Biogeochemical cycles- Carbon, Nitrogen, Sulphur and Phosphorus cycles. Soil Analysis- Importance for Agriculture sampling, preliminary field tests, sample preparation, preliminary qualitative laboratory tests and Analytical techniques. Applications of Microorganisms in Agriculture: Bio fertilizers and plant nutrition

Microbial inoculants- Isolation, identification, mass cultivation, Carrier based inoculum preparation, curing, packaging and storage of *Rhizobium*, *Azotobacter*, *Azospirillum*, Phosphate solubilising microorganisms, Blue green Algae, *Azolla*, and other novel microbial inoculants developed for the increase of yield Quality control of bioinoculants. Bioorganic farming.

Biological control by soil amendments spoil treatment with selected chemicals, seed inoculation, vegetative part inoculation & soil inoculation, use of Mycorrhizal fungi. Microbial pesticides- Bacterial, viral and fungal pesticides, Biological control of weeds, Mycoherbicides, insects as biocontrol agents. Genetic engineering of biocontrol agents. Microbiological control of pests – using Entomopathogenic fungi, Floriculture- disease control, Solar green house, Insecticide resistant management, Foliar application of nutrients to crops. Microorganisms in Agro processing- Jute and flax retting, coir production, preservation of forages, curing of tea, coffee etc, processing of leathers and paper making.

Genetic engineering for resistance in plants and for crop improvement, production of pathogen free plants, improvement of nutritional quality. Rapid cloned propagation, germ plasm storage. Plant and their interactions include transgenic microbes and plants. Biological control of diseases by PGPR. Nanotechnology in Agriculture- In Controlled Environment Agriculture (CEA), Nano-emulsions, Nanofiltration technology. Autonomous sensors in nanotechnology for agricultural application.

Environmental concepts and components- Productivity, food chain, energy flow, types of ecosystem. Population, community, the interconnecting web of life. The organisation of ecosystem, energy and nutritional flow in ecosystem. Ecological interactions between organisms in a community. Population ecology, biodiversity and conservation- *Exsitu* and *insitu* conservation. Community structure and organisation: biogeochemical cycles, cycling of toxic metals, Bioaccumulation and biomagnification. Environmental pollution- toxicity, persistence, mobility, ease of control, chemistry of pollution, dilution and dispersal of soil, water and air. Concentration and contaminant practical toxicity issues, practical application to pollution control. Biochar production, pyrolysis technology

Marine and freshwater environment- nature and level of nutrients, microbial mats and microbial communities, nutrient removal from water. Natural microflora of water, eutrophication, & water borne diseases. Permissible limits and indices of pollution- hazardous wastes and priority pollutants, microbial degradation of toxic chemical and organic compounds. Sewage water treatment- microbiological analysis of water, measurement of DO, BOD, COD, primary, secondary and tertiary treatment, pollution assessment and uses of microorganisms in treatment. Sewage and sewage disposal- Collection.

... a medium for growth of microorganisms, air microorganisms, air pollutants- primary, secondary, allergens, aerosols, droplet nuclei. Air sampling methods, purification techniques and air borne diseases. Microbes in air pollution control- biological filters, bioscrubbers, biosensors and bioreactors.

Soil microbiology- nature and soil quality, soil microflora and factors influencing growth, water, formation of organic matter, and recent techniques for quantitative and qualitative analysis of soil microflora, soil pollutants. Indicators of pollution and control measures. Leaching of ores and recovery of metals, desulphurisation of coal- Bio leaching, bio insecticides, Bio fertilizers. Concepts of bioremediation- DDT, 2,4D, chlordane, dieldrin, parathion, thiram, paraquat, PCP, carbofuron, detergents, hydrocarbons etc. Microbial degradation of Xenobiotic compounds

Occurrence and distribution of microorganisms in outer space, significance and advances in space microbiology. Concept of bioterrorism- history, concept, type of agents- anthrax, smallpox, botulinum toxin, plague etc. Bioethics- ethical and moral issues in biological and biotechnological research, biosafety and research- general guidelines for rDNA research activity, purposes and scope, perspectives, implications of ethical conduct.

Bio-energy- biofuels- bioethanol, biodiesel, biogas and hydrogen gas, biomass energy.



## MEDICAL MICROBIOLOGY

100 marks

4 hrs / week

Total hrs 60

Concepts of Immunology - Historical prospective, early vaccination studies, Humoral and Innate immunity. Immune Dysfunction and its consequences. Haematopoiesis, Cells of the immune system, Clinical focus on stem cells, Organs of the Immune system - primary and secondary. Antigens - Immunogenecity verses antigenecity, Haptens as diagnostic tools, Epitopes. Study of pathogens.

Immunoglobulins - Structures and functions; Monoclonal antibodies and their clinical uses, Alozymes, Generation of Antibody, Diversity, Expression of Immunoglobulin genes. Regulation of Ig- gene transcription, Antibody genes and Antibody engineering. Antigen-Antibody interactions: Strength of Antigen- Antibody interactions, cross reactivity, Surface plasmon response (SPR), precipitation reactions, Agglutination reactions, Radioimmunoassay, ELISA, Western blotting, Immunoprecipitation, Immunofluorescence, clinical focus flow cytometry and Leukaemia typing, Immunoelectron microscopy

Complement System - Functions of complement, components of complement, complement activation, regulation of complement system, Biological consequences of complement activation. The major Histocompatibility complex: General organization and Inheritance of MHC, MHC molecules and genes, detailed genomic map of MHC genes, Cellular expression of MHC molecules, Regulation of MHC expression, MHC and disease susceptibility, Presentation of Antigens, T-cell receptors, T-cell maturation, activation and differentiation, B-cell generation, activation and differentiation.

Immuno Effector Mechanisms - Cytokines- properties, receptors of cytokines, cytokine antagonists, cytokine related diseases, cytokine based therapies, cytokine in haematopoiesis Clinical focus therapy with interferons. Leukocyte Activation and Migration: Cell adhesion molecules, chemokines, mediators of inflammation, inflammatory response, clinical focus leukocyte adhesions, Deficiency in humans.

Anti-inflammatory agents - Hypersensitivity reactions- IgE-mediated hypersensitivity Clinical focus -the genetics of Asthma, Antibody mediated cytotoxic hypersensitivity, immune complex mediated hypersensitivity, delayed type hypersensitivity. Immune System in Health and Diseases- Autoimmunity- organ specific auto immune diseases, Systemic autoimmune diseases, Animal models for Autoimmune diseases, Evidence implicating the CD4<sup>+</sup> T-cell, MHC and TCR in autoimmunity. Clinical focus on autoimmune diseases, Treatment of autoimmune diseases.

Transplantation Immunology - Immunologic basis of graft rejection, Clinical manifestations of graft rejection, General Immunosuppressive therapy, Clinical transplantation.

...infections, Bacterial infections  
...among infectious diseases, Vaccines- Clinical focus  
...immunization.

... primary Immunodeficiencies, AIDS and other  
... prevention of infant AIDS by Anti-Retroviral  
... origin and terminologies, malignant  
... Tumor antigens- clinical focus, a vaccine  
... immunotherapy.

... experimental animal methods, cell culture systems, protein  
... regulatory sequences, gene transfer into  
... approach for analysing patterns of gene expression, clinical  
... tool for human disease. Two photon microscopy for  
... advances in fluorescent technology.

... Methodology and application involved in  
... detection of pathogens, use of bee venom has harnessed to  
... articles.

... compounds, its application, methods of extraction, purification.  
... use of antibiotics, prevention, control and detection of  
... Plant based drugs in modern health care, rDNA for  
... vaccines.



## REFERENCES

1. Black, J. G., Microbiology. John Wiley and Sons. INC
2. Glick, B. R and Pasternok., Molecular Biotechnology. ASM Press Washington
3. Mueller, G. M., Bills, G. F and Foster, M. S., Biodiversity of Fungi. Elsever Academic Press
4. Roilt, I. M and Delres, P. T., Essential Immunology. Blackwell Publishing
5. Thomas, T., Richard, A., Barbara, A., Kindt., Goldsby and Osborne., Immunology. W. H. Freeman and Company
6. Tortora, G. J., Funke, B. J and Case, C. L., Microbiology. Pearson Education
7. Ralledge, C and Kristianson, B., Basic Biotechnology. Cambridge University Press
8. Stefan, H. E., Kaufmann and Kabelitz, D., Immunology of Infection. Academic Press
9. Kreuzer, H and Massey, A., Recombinant DNA and Biotechnology. ASM Press
10. 'Siderophores' the unique iron chelators. J. Advanced biotech(2007)
11. Gene test reveals arsenic releasing microbes in water. J. Advanced biotech(2004)
12. Meta population structure of bacteria among coastal marine invertebrates. J. Environmental microbiology (2009)
13. Heavy metal pollution and chemical profile of Cauvery river water. E-Journal of chemistry (2008)
14. Physicochemical characteristic and phytoplankton of Taudaha lake, Kathamandu. J. Kathamandu (2008).
15. Bioterrorism: exploiting microorganisms for human desolation: J. Advanced biotech (2007)
16. Bacteria employ type of DNA modification never seen in nature. J. Advanced biotech (2008).
17. Vaccine made with synthetic gene protects against deadly pneumonia. J. Advanced biotech (mar-2011)
18. UCF professors finds new way deadly food borne bacteria spread: Advanced biotech (Oct-2009)
19. Friendly bacteria in human may protect against HIV. J. Advanced biotech(may-2005)
20. Oral vaccine containing Salmonella may protect against aerosolized anthrax. J. Advanced biotech (oct-2007)
21. Providing powerful protection from inhaled deadly pathogens. J. Advanced biotech (Dec-2007)
22. Comparison of antibiotic resistance patterns of structurally diverse group of antibiotics against *Pseudomonas*: Bioluminescence. J. Advanced biotech (sep-2008)
23. Cloning and molecular characterization of chitinase from *Bacillus lichiniformis* Ms-3. J. Gen. Applied. microbiology (2000)
24. Resistance to antibiotics and heavy metals in *Enterobacteriaceae* Sp. isolated from gills and intestine of *Acanthobrama marmid* from Sir Dam lake Turkey. J. Environmental biology (2009)
25. Characterization of Multiple antibiotic resistant *E.coli* from Sewage and microbial polluted water. J. Environmental Biology (2009)
26. Microbial pigments. J. Advanced biotech (Feb-2005)
27. Radio resistance of nitrogen fixing cultures of *Anabaena* strains: journal of Bioscience (sep- 2009)
28. Bioethanol production from *Lemna gibba* L. J. current science(nay-2010)
29. Gene sequencing will aid in biomass to biofuels: Advanced biotech(Mar-2007)
30. Microbes convert Styrofoam into <sup>TM</sup> biodegradable plastic. J. Advanced biotech (Mar-2006)

31. Bacteria shed light on important group of human protein. J. Advanced biotech (2007)
32. Biofilms an extreme focus. J. Advanced biotech(2008)
33. Antimicrobial protein from *Streptomyces fulvissimus* inhibitory to methicilin resistant *Staphylococcus aureus*. Indian journal of experimental biology (2008)
34. Bioluminescence. J. Biotechnology (Feb-2000)
35. Microbial endophytes. J. Advanced biotech (Aug-2007)
36. Biodiesel from micro Algae. J. Advanced biotech(Nov-2008)
37. Studies on Follicolous fungi. J. Mycopathol. (2006)
38. One new species of *Meliola* found in India. J. Indian Phytopathology (2008)
39. *Meliolaceae* of Kerala, India. J. Indian Phytopathology (2007)
40. Investigating microbial community structure in soil by physiological, biochemical and molecular fingerprinting methods: European Journal of soil science (2006)
41. Molecular mechanisms underlying the tolerance of biofilm bacteria to antimicrobial agents and other industrial products. J. FEMS Immunology and medical microbiology
42. Effect of Probiotic *Lactobacillus* sp. on ornamental fish against pathogenic *Vibrio* sp.: Indian journal of biotechnology (2008)
43. Dietary yeast extracts tested as alternative to antibiotics in poultry. J. Advanced Biotech (2008)
44. Probiotics may reduce rate of recurrent urinary tract infection in women. J. Science daily.
45. Agrobios, Newsletter (May, 2011)
46. Birge, E. A., Bacterial and Bacteriophage Genetics (2000)
47. Springer-Verlag and Mathew., Bacteriophage Biochemistry. Am. Chemical Soc. (1972)
48. Mathew, C. K., Kutter, E. M., Mosig, G and Berget, P., Bacteriophage (1988)
49. Ahluwalia, A. S., Phycology: Principles, Processes and Applications. Daya Publ. Barsanathi L (2003)
50. Carr, N. G and Whitton, B. A., The Biology of Cynobacteria (1982)
51. Kumar, H. D., Introductory Phycology. East West Press (2005)
52. Linda, E., Graham and Lee, W. Wilcox., Algae. Prentice Hall (2000)
53. Vekataraman, L. V and Becker, E. W., Biotechnology and Utilization of Algae: the Indian Experience (1985)
54. Alexander, M., Soil Microbiology. John Wiley (1977)
55. Hawker, L. E and Linton, A. H., Microorganisms Function, Form and Environment. 2<sup>nd</sup> Ed (1989)
56. Edward Arnold and James, M. Jaq., Modern Food Microbiology. CBS (1987)
57. Stanbury, P. F and Whitaker, A., Principles of Fermentation Technology. Pergamon Press(1987)
58. peppler, H. J and Perlman, D., Microbial Technology. 2<sup>nd</sup> Ed. Academic Press (1979)

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