

# M.Sc. (FERMENTATION & MICROBIAL TECHNOLOGY)

## (SEMESTER SYSTEM)

### Scheme of Courses

#### Ist Semester

1. FMT 101	Concepts in Microbiology	20 + 80
2. FMT102	Food Processing Technology	20 + 80
3. FMT103	Fermentation Technology	20 + 80
4. FMT104	Biochemical Biophysical Techniques	20 + 80
5. P1-FMT	Food Processing and Fermentation Technology Lab	50
6. P2-FMT	Microbiological & Biochemical Techniques	50
<b>Total</b>		<b>500</b>

---

#### IInd Semester

1. FMT 201	Molecular Biology and Genetic Engineering	20 + 80
2. FMT 202	Biochemical Engineering	20 + 80
3. FMT 203	Food Hygiene and Quality Control	20 + 80
4. FMT 204	Waste Recycling	20 + 80
5. P1 - FMT	Techniques in Molecular Biology and Biochemical Engineering	50
6. P2 - FMT	Waste Recycling & Quality Control Lab	50
<b>Total</b>		<b>500</b>

---

## M.Sc. (FERMENTATION & MICROBIAL TECHNOLOGY)

### (SEMESTER SYSTEM)

#### Scheme of Courses

#### III<sup>rd</sup> Semester

1. FMT 301	Advances in Industrial Microbiology	20 + 80
2. FMT 302	Environmental Biotechnology	20 + 80
3. FMT 303	Malting Brewing & Enzyme Technology	20 + 80
4. FMT 304	Computer Programming and Bioinformatics	20 + 80
5. P1-FMT	Industrial & Environmental Biotechnology Lab	100
<b>Total</b>		<b>500</b>

---

#### IV<sup>th</sup> Semester

1. FMT 401	Seminar	100
2. FMT 402	Recent Advances in Fermentation	100
3. FMT 403	Biostatistics	20 + 80
3. FMT 404	Industrial Training Report/ Dissertation	200
<b>Total</b>		<b>500</b>

---

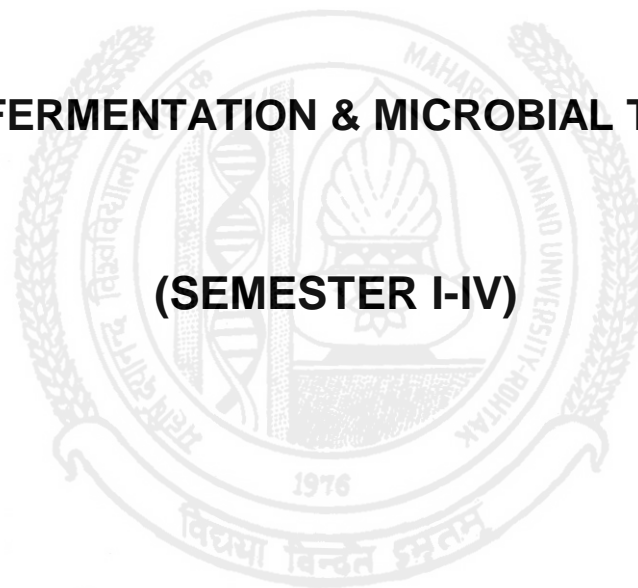
Department Of Microbiology

(Faculty of Life Sciences)

Syllabus

**M. Sc. (FERMENTATION & MICROBIAL TECHNOLOGY)**

**(SEMESTER I-IV)**



**Academic session - 2010–11**

**Maharshi Dyanand University,  
Rohtak-124001**

**M.Sc. (FERMENTATION & MICROBIAL TECHNOLOGY)  
(SEMESTER-I)**

**FMT 101 Concepts in Microbiology**

**Time: 3hrs**

**Marks: 80**

**Note:- The question paper will consist of 9 questions. Students will have to attempt 5 questions in total - Question no. 1 will comprise of short answer questions covering the entire syllabus and will be compulsory. - Two questions to be set from each Unit and students will have to attempt one from each Unit.**

**Unit-I**

Historical developments of microbiology scope of microbiology, Brief account of organization and classification of microorganisms. Differences between prokaryotic and eukaryotic cell. Overview of bacterial cell structure, (size, shape, arrangement membrane, cell wall, cytoplasmic inclusions, mesosomes, flagella and motility, slime, capsule, pili, chemotaxis, endospore) The brief account of fungi, structure, physiology and classification, brief account of virus (bacteriophages) structure, life cycle (lytic and lysogenic).

**Unit-II**

Microscopy: Principles and applications in microbiology, brightfield microscopy, darkfield microscopy, fluorescence and immuno fluorescence microscopy, phase contrast and electron (transmission and scanning) microscopy. Staining of microorganisms. Reproduction and Growth: Life cycles of representative microorganisms including bacteria, fungi and viruses, population growth and its measurement, effect of environmental condition on growth pH, temp. aeration etc, continuous culture, diauxic, synchronous growth cultures and anaerobic cultures.

**Unit-III**

Nutrition and Metabolism: Modern concepts of bacterial nutrition, nutritional categories. Transport of nutrients (diffusion, active transport, group translocation) Introduction to oxidative and substrate level phosphorylations, brief account of metabolism of carbohydrates, EMP, ED, TCA and glyoxylate cycle and nucleic acids as building block in biosynthesis of cell constituents synthesis of peptidoglycan polymer of cell wall,

**Unit-IV**

Microbial Genetics: A general account of prokaryotic and eukaryotic genome, recombination, brief account of transformation, conjugation, transduction. concept of operon, induction, repression, catabolite repression. Control of Microorganisms: Control of microbes by physical and chemical agents. Antibiotics, properties and mode of action; Drug resistance and its significance. Antibiotic sensitivity test. Industrial uses of bacteria yeast & molds.

**M.Sc.(FERMENTATION & MICROBIAL TECHNOLOGY) (SEMESTER-I)****Books****Recommended:**

1. Stanier, R.Y. Adelberg, E.A. and Ingraham, J.L. (1984), General Microbiology, IV edn. Mac Millan Press.
2. Pelczar, M.J. Chan, E.C.S. and Krieg, N.R. (1986), Microbiology, V Ed. Mc 3. Graw Hill.
4. Prescott. L.M. Harley J.P. and L. Kreig D.A. (1990). Microbiology, WCB Publishers.
5. Rosenberg, E & Cohen I.R. (1983). Microbial Biology. H.S. International Editions.



5  
**M.Sc. (FERMENTATION & MICROBIAL TECHNOLOGY)**  
**(SEMESTER-I)**

**FMT 102 Food Processing Technology**

**Time: 3hrs**

**M. Marks: 80**

**Note:** - The question paper will consist of 9 questions. - Question no. 1 will comprise of short answer questions covering the entire syllabus and will be compulsory. - Two questions to be set from each Unit and students will have to attempt one from each Unit.

**Unit-I Causes of food spoilage:** Microbiological and food enzymes, insects, parasites, rodents, temperature, moisture, oxygen, light and time. General principles of food preservation. Production of cultures for food fermentation: general principles of culture preparation, bacterial cultures, yeast cultures, mold cultures.

**Unit-II**

Processing and spoilage of vegetables and fruits (sauerkraut, pickles, jam, jellies, marmalades, juices, syrups, ketchups); Cereal products (Soya sauce, miso, tempeh. Idli, dosa, bread, cakes); meat, egg and fish products.

**Unit-III**

Processing of milk and milk products. Microbiology and spoilage of dairy products: Cheeses, fermented milk, cultured butter milk, yogurt, kefir, koumiss, Bulgarian milk, acidophilus milk, dahi, tea, coffee.

**Unit-IV**

**Food Additives:** Nutrients, antimicrobial agents, antioxidants, flavoring agents, sweetness, colors, emulsifiers, enzymes, polysaccharides and other miscellaneous food additives. Cleaning and disinfection methods-Introduction, definitions, types of soil, detergents, chemical disinfectants, heat treatment, dry cleaning, cleaning-in-place (CIP), mechanical aids for cleaning, wipers, cleaning schedules, use of labour and role of management.

**Books Recommended**

1. Potter, N.M. (1980), Food Science. The AVI Publishing Co. Westport Connecticut, USA. 2. Desrosier, Norman W. and Desrosier, James, N. (1986). The technology of food preservation 4<sup>th</sup> edition. The AVI publishing Co. Inc. USA. 3. Branen, Lassy A. David-san Michael P. and Salminen Seppo (1990). Food additives. Published by Marcel Dekker Inc. New York. 4. Hayes P.R. (1992). Food microbiology and hygiene. Elsevier Science Publishers Ltd. England. 5. Matz. Samuel A. The chemistry and technology of cereals as food and feed. The AVI Publishing Co. Westport Connecticut, USA. 6. Jelling, Gisela. Sensory evaluation of Food-Theory and Quality control for fruits and vegetable products. 2 Edition. Tata McGraw Hill Publishing Co. Ltd. New Delhi.

**M.Sc. (FERMENTATION & MICROBIAL TECHNOLOGY)  
(SEMESTER-I)**

**FMT103 Fermentation Technology**

**Time: 3hrs**

**M. Marks: 80**

**Note:- The question paper will consist of 9 questions. Students will have to attempt 5 questions in total - Question no. 1 will comprise of short answer questions covering the entire syllabus and will be compulsory. - Two questions to be set from each Unit and students will have to attempt one from each Unit.**

**Unit-I**

Introduction to fermentation technology: Interaction between chemical engineering, Microbiology and Biochemistry. History of fermentation. Introduction to fermentation processes, Microbial culture selection for fermentation processes. Media formulation and process optimization.

**Unit-II**

Gaden's Fermentation classification, Design and operation of Fermenters, Basic concepts for selection of a reactor, Packed bed reactor, Fluidized bed reactor, Trickle bed reactor, Bubble column reactor, Scale up of Bioreactor.

**Unit-III**

Down Stream processing. Recovery of particulate matter, product isolation, distillation, centrifugation, whole broth processing, filtration, aqueous two-phase separation, solvent extraction, chromatography and electrophoresis.

**Unit-IV**

Bioprocess economics. Bioproduct regulation. General fermentation economics.

**References :**

1. Biely, J.E. and Ollis D.F. Bio Chemical Engineering Fundamentals (1986) Megraw Hills.
2. Rehm, H.J. and Reed G (ed), Biotechnology, Vol 1-2, Verlag chemie.
3. Stanbury, P.E. and Whitaker A., Principles of Fermentation Technology (1984) Pergamon Press.
4. Pirt, S.J. Principles of Microbial and Cell Cultivation. Blackwell Scientific Publication, London.
5. Moo-young M. Comprehensive Biotechnology Vol. 1-4 Pergamon Press Oxford.

7

**M.Sc. (FERMENTATION & MICROBIAL TECHNOLOGY) (SEMESTER-I)**

**FMT 104 Biochemical Biophysical Techniques**

**Time: 3hrs**

**M. Marks:80**

**Note:- The question paper will consist of 9 questions. Students will have to attempt 5 questions in total - Question no. 1 will comprise of short answer questions covering the entire syllabus and will be compulsory. - Two questions to be set from each Unit and students will have to attempt one from each Unit.**

**Unit-I** Theory and applications of chromatographic techniques: Paper chromatography, thin layer and column chromatography, ion exchange and affinity chromatography, reverse-phase chromatography, GLC/HPLC and FPLC.

**Unit-II** Conventional and modern methodology for protein separation: theory and application of polyacrylamide gel electrophoresis, iso electric focusing, isotachopheresis, pulse field gel electrophoresis, immunodiffusion and immuno electrophoresis methods.

**Unit-III** Theory and application of analytical and preparative centrifugation. Concept of continuous and zonal rotors, analytical centrifuge. Introduction to radioisotopes and their monitoring concepts of counting efficiency and auto radiography.

**Unit-IV**

Theory and application of UV visible, infrared NMR,MR, GC-MS spectroscopy Principles and applications of serodiagnostic techniques.

**Books Recommended**

1. Friefelder. D. (1982) Physical Biochemistry, Application to Biochemistry and Molecular Biology, 2<sup>nd</sup> ed. W.H. Freeman and Company, San Fransisco.
2. Griffiths, O.M. (1983). Techniques of Preparative, Zonal and Continuous Flow Ultracentrifugation. Bechman's Ultracentrifuge Manual.
3. William, B.L. and Wilson, K. (1986). A Biologist Guide to Principles and Techniques Practical Biochemistry, 3 ed., Edward Arnold Publisher, Baltimore, Maryland (USA).
4. Slater, R.J. (1990). Radioisotopes in Biology-A Practical Approach, Oxford University Press, New York.



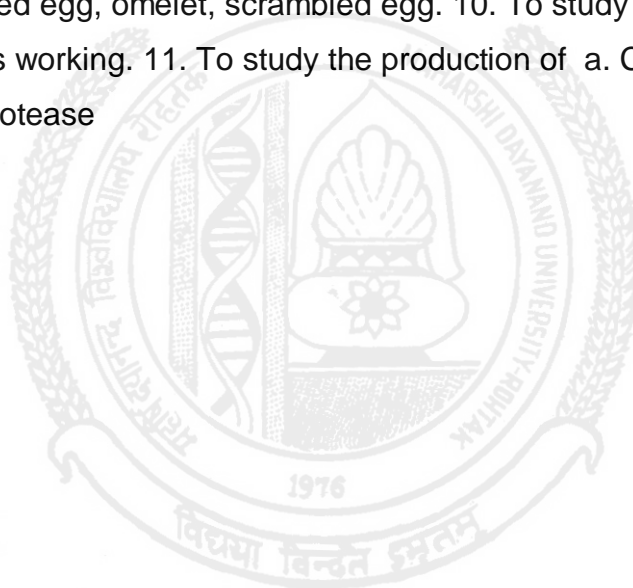
8  
**M.Sc. (FERMENTATION & MICROBIAL TECHNOLOGY)**  
**(SEMESTER-I)**

**P – FMT1 Food Processing and Fermentation Technology Lab**

**Time: 4 hrs**

**M. Marks: 100**

1. To draw layouts of different food industries.
2. To plan normal and therapeutic diets.
3. Preparation of juice, squash, syrup, jam, chutney, ketchup.
4. Drying of vegetables, canning of vegetables/fruits.
5. Standardization of milk.
6. Preparation of dahi, lassi, shrikhand, paneer, chhana, flavoured milk.
7. Preparation of cakes.
8. Preparation of idli, dhokla, dosa warha etc.
9. Preparation of boiled egg, poached egg, fried egg, omelet, scrambled egg.
10. To study the design of fermenter and its working.
11. To study the production of  
a. Citric Acid  
b. Ethanol  
c. Amylase  
d. Protease



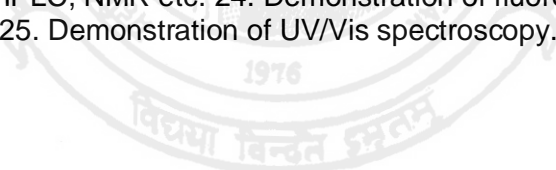
9  
**M.Sc. (FERMENTATION & MICROBIAL TECHNOLOGY)**  
**(SEMESTER-I)**

**P-FMT 2 Microbiological & Biochemical Techniques**

**Time : 4hrs**

**Max Marks : 80**

1. Isolation and enumeration of bacteria from soil by serial dilution agar plating method.
2. Isolation and enumeration of actinomycetes from soil.
3. Microbiological and cultural characterization of bacteria and actinomycetes.
4. Staining of bacteria: Simple staining, negative staining, gram staining, acid fast staining, spore staining, capsule staining.
5. To perform various biochemical tests of bacteria: Acid and gas production from sugars, gelatin liquefaction, starch hydrolysis, casein hydrolysis, nitrate reduction, indole production, H<sub>2</sub>S production, methyl red test, Vogues Proskauer test, citrate utilization, catalase activity, urea<sup>2</sup> activity, oxidase activity.
6. Agarose Gel electrophoresis.
7. SDS page electrophoresis.
8. Estimation of Protein in virus infected & normal plants.
9. Screening of industrially important microorganisms from soils, food processing waste and ... animal droppings.
10. To evaluate the production of alcohol from molasses, & Ligno-cellulosics.
11. Microbial biomass production (fungi/bacteria/yeast), batch and continuous culture.
12. To compare production of citric acid using sucrose and molasses as carbon source.
13. Production of lactic acid using cheese whey as substrate.
14. Production of extra cellular enzymes (amylases, proteases, xylanases) by thermophilic and mesophilic fungal culture.
15. To isolate rare genera of microorganisms for novel antibiotic production, and to evaluate the potential of different media for antibiotic production.
16. To isolate spontaneous mutants from various cultures after repeated sub culturing.
17. To induce the mutagenesis by different mutagenic agents such as NTG/UV for strain improvement.
18. To characterize the auxotrophic mutants by replica plating method.
19. To isolate 2-deoxy glucose resistant mutants for isolating catabolic repression negative mutants.
20. To study the protoplasting and regeneration in fungi.
21. To study DNA isolation and gel electrophoresis.
22. To study thin layer chromatography & paper chromatography.
23. To study the working of GLC, HPLC, NMR etc.
24. Demonstration of fluorescence, phase contrast and electron microscopy.
25. Demonstration of UV/Vis spectroscopy.



**M.Sc. (FERMENTATION & MICROBIAL TECHNOLOGY)  
(SEMESTER-II)**

**FMT 201 Molecular Biology & Genetic Engineering**

**Time: 3hrs**

**M. Marks: 100**

**Note:- The question paper will consist of 9 questions. Students will have to attempt 5 questions in total - Question no. 1 will comprise of short answer questions covering the entire syllabus and will be compulsory. - Two questions to be set from each Unit and students will have to attempt one from each Unit. Unit-I**

Nucleic acids: structure of DNA, functions, replication, DNA damage and repair, isolation and sequencing. Transcription; types of RNA and their role in gene expression,

**Unit-II**

Translation; components involved, t-RNA as adapter, genetic code and its salient features, gene expression; inducible and repressible operon (account of *lac* operon and *trp* operon regulation)

**Unit-III**

Molecular mechanism of recombination, proteins involved in recombination, Transposons; types and mechanism of transposition, Transformation, conjugation and transduction, their mechanism and significance.

**Unit-IV**

Molecular cloning; techniques and their importance, cloning vectors; properties and uses, selection and characterization of clones, gene probes, labeling. PCR; principle, types and role in molecular biology Bioinformatics ; proteomics and genomics studies and their significance.

11  
**M.Sc. (FERMENTATION & MICROBIAL TECHNOLOGY)**  
**(SEMESTER-II)**

**FMT 202 Biochemical Engineering**

**Time: 3hrs**

**M.Marks:80**

**Note:- The question paper will consist of 9 questions. Students will have to attempt 5 questions in total - Question no. 1 will comprise of short answer questions covering the entire syllabus and will be compulsory. - Two questions to be set from each Unit and students will have to attempt one from each Unit.**

**Unit-I** Introduction to bio-chemical engineering: Interaction between chemical engineering, Microbiology and Biochemistry, Simple enzyme kinetics and Enzyme inhibition kinetics.

**Unit-II**

Stoichiometry of cell growth. Monod's Growth kinetics, Specific growth rate, growth yield, production yield,  $Y_g$ ,  $Y_{o_2}$ ,  $Y_{atp}$ , Saturation constant, maintenance energy, Transient growth.

**Unit-III** Kinetics of media sterilization, Design of batch and continuous sterilization processes. Calculation of  $D_{el}$  factor and holding time. Richard's rapid methods of design of sterilization process. Scale up of batch sterilization process. Methods of air sterilization process. Design of air filters, effects of bed depth and air velocity on filtration.

**Unit-IV**

Product synthesis kinetics. Growth and non growth synthesis. Open and closed system of fermentation. Mathematical model for batch fermentation. Plug flow reactor and its kinetics. Continuous Stirred Tank Reactor (CSTR). Steady state model for CSTR. Rate of biomass production in a chemostat.

**Books Recommended:**

1. Biely, J.E. and Ollis D.F. Bio Chemical Engineering Fundamentals (1986) Mcgraw Hills.
2. Rehm, H.J. and Reed G (ed), Biotechnology, Vol 1-2, Verlag-chemie.
3. Stanbury, P.E. and Whitaker A., Principles of Fermentation Technology (1984) Prgamon Press.
4. Pirt, S.J. Principles of Microbial and Cell Cultivation. Blackwell Scientific Publication, London.
5. Moo-young M. comprehensive Biotechnology Vol. 1-4 Pergamon Press Oxford.

**M.Sc. (FERMENTATION & MICROBIAL TECHNOLOGY)  
(SEMESTER-II)  
FMT 203 Food Hygiene & Quality Control**

**Time: 3hrs**

**M. Marks: 100**

**Note:- The question paper will consist of 9 questions. Students will have to attempt 5 questions in total - Question no. 1 will comprise of short answer questions covering the entire syllabus and will be compulsory. - Two questions to be set from each Unit and students will have to attempt one from each Unit.**

**Unit-I** Cleaning and disinfection methods-Introduction, definitions, types of soil, detergents, chemical disinfectants, heat treatment, dry cleaning, cleaning-in-place (CIP), mechanical aids for cleaning. Wipers, cleaning schedules, use of labour and role of management.

**Unit – II** Definition of quality and quality control. Classification of quality attributes, responsibilities and organization of quality control department and its relation with other departments of industry. Sensory analysis-Introduction, general testing conditions, taste, odour, aroma and other senses.

**Unit-III** Chemical analysis for various products like:- fruits and vegetable products cereal and cereal products, milk and milk products, egg, meat, fish. Food Laws, grades and standards for different food products.

**Unit-IV**

Microbiology quality control: Quality and criteria, sampling scheme, microbiological parameters for codes of good manufacturing practice. Hazard analysis and critical control points. Methods for microbiological examination of foods (Direct Examination, cultural techniques), enumeration methods. Alternate indirect methods (dye reduction, electrical, ATP), rapid methods for detection of specific organisms and toxins (immunological/molecular methods).

**Books**

**Recommended:**

1. Hayes P.R. (1992). Food microbiology and hygiene. Elsevier Science Publishers Ltd. England.
2. Jelling, Gisela. Sensory evaluation of food-theory and quality control for fruits and vegetable products. 2 Edition. Tata McGraw Hill Publishing Co. Ltd., New Delhi.
3. Krammer A & Twigg BA. Quality control in food Industry Vol. I.
4. Krammer A & Twigg BA. Quality Control in Food Industry Vol. II.
5. Aurand L.W. and Wood AE. Food composition and Analysis.

**M.Sc. (FERMENTATION & MICROBIAL TECHNOLOGY)  
(SEMESTER-II)**

**FMT 204 Waste Recycling**

**Time: 3hrs**

**M. Marks: 80**

**Note:- The question paper will consist of 9 questions. Students will have to attempt 5 questions in total - Question no. 1 will comprise of short answer questions covering the entire syllabus and will be compulsory. - Two questions to be set from each Unit and students will have to attempt one from each Unit.**

**Unit-I**

Ecological aspects of biodeterioration control soil, waste and water management, treatment of solid wastes (landfills, sanitary landfills, composting aerobic and anaerobic).

**Unit-II**

Treatment of liquid waste: Waste water characteristics, activated sludge process, waste stabilization ponds, anaerobic fixed film systems, anaerobic degradation of toxic and hazardous wastes. Mixed culture interaction during waste water treatment, high rate anaerobic filters. Upflow anaerobic sludge blanket. Down flow stationary fixed film reactor.

**Unit-III**

Testing for biodegradability, biomagnification, bioremediation, efficacy testing, side effect testing, approaches to bioremediation. Environmental modification for bioremediation. Microbial seeding, a bioengineering approaches to the bioremediation of pollutants.

**Unit-IV**

Waste recycling in agriculture: Significant recyclable resources, composting, recycling of crop residues, recycling of rural and urban wastes through conventional and vermicomposting commercial scale technology for organic fertilizer from waste. Role of microbial sensors in environment monitoring: BOD and methane sensors.

**Books**

**Recommended:**

1. Tandon, H.L.S. (Ed) 1995. Recycling of crop, animal human and Industrial wastes in agriculture. Fertilizer development and consultation organization New Delhi, India.
2. Wesley Eckenfeldev. W. 1989. Industrial waster pollution control. McGraw Hill Inc. U.S.A.
3. Atlas, R.M. and Bartha, M. 1991. Microbial Ecology; Fundamentals and applications Addison Wesley, Philippines.

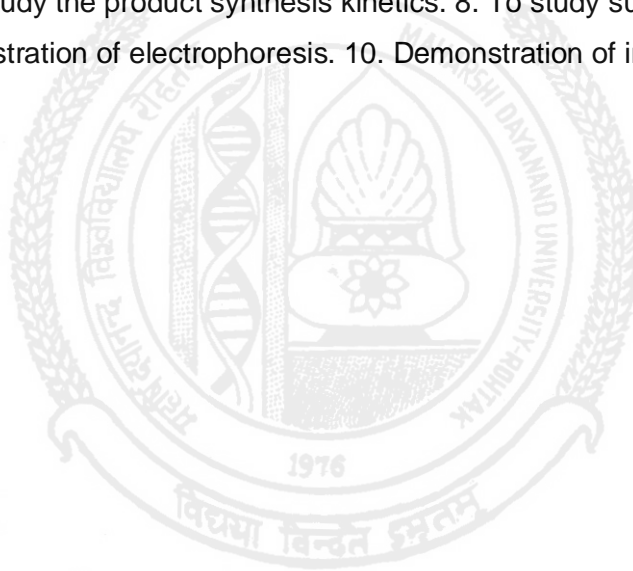
**M.Sc. (FERMENTATION & MICROBIAL TECHNOLOGY)  
(SEMESTER-II)**

**P1 - FMT Techniques in Molecular Biology and Biochemical Engineering**

**Time: 4hrs**

**M. Marks: 100**

1. To measure the DNA content in a given sample.
2. Isolation of genomic DNA and plasmid DNA of microorganisms by mini prep protocol.
3. Microbial growth kinetic studies.
4. Effect of different temperature on yeast growth.
5. Effect of aeration on growth kinetics of yeast.
6. To study the diauxic growth.
7. To study the product synthesis kinetics.
8. To study substrate consumption rate.
9. Demonstration of electrophoresis.
10. Demonstration of immobilization techniques.



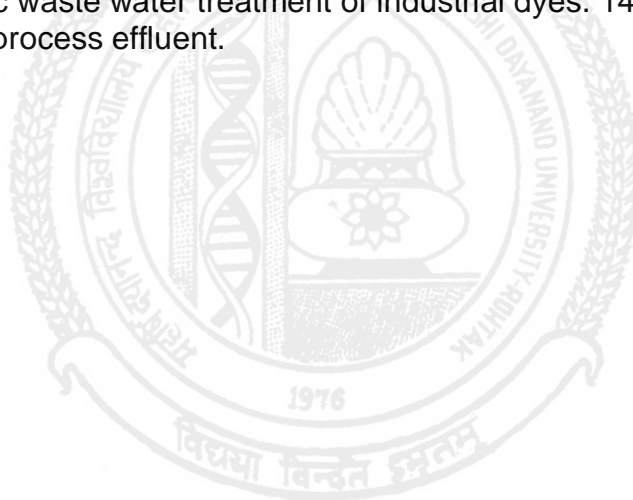
15  
**M.Sc. (FERMENTATION & MICROBIAL TECHNOLOGY)**  
**(SEMESTER-II)**

**P2 - FMT Waste Recycling & Quality Control Lab**

**Time: 4hrs**

**Max. Marks:80**

1. Platform tests for milk like taste, odour, consistency, COB, alcohol test, acidity etc. 2. Detection of various additives/preservatives/neutralizers in milk. 3. To determine Fat%, T.S.%, SNF%, Protein%, Lactose% in milk, Ash%. 4. Microbiological examination of milk like MBRT, SPC etc. 5. Physical & chemical examination of cereals. 6. Grading of eggs without breaking (candling of eggs) and after breaking, albumen and yolk index, condition of albumen and yolk, shell thickness and observation of defects if any. 7. Preservation of eggs. a. Cold storage b. Thermal stabilization c. Mineral oil coating etc. 8. Quality control tests for fruits & vegetable products prepared in the lab, (Sensory, chemical and microbiological). 9. To study different properties of packaging materials. a. Permeability b. Grease resistance c. Wax coating d. Porosity of tin plate. 10. To determine shelf life of prepared, packaged foods. 11. Sensory analysis of various products prepared in semester-I 12. Isolation of xenobiotic degrading microorganisms 13. Anaerobic waste water treatment of industrial dyes. 14. The anaerobic waste water treatment of process effluent.





16  
**M.Sc. (FERMENTATION & MICROBIAL TECHNOLOGY)  
(SEMESTER-III)**

**FMT - 301 Advances in Industrial Microbiology**

**Time: 3hrs**

**M. Marks: 80**

**Note:- The question paper will consist of 9 questions. Students will have to attempt 5 questions in total - Question no. 1 will comprise of short answer questions covering the entire syllabus and will be compulsory. - Two questions to be set from each Unit and students will have to attempt one from each Unit.**

**Unit-I**

Microbial biodiversity and its importance in industrial microbiology, methods of isolation, screening of microbes with unique properties. Culture collection, cataloguing of cultures, methods of culture maintenance, raw materials of industrial importance, medium formulation, methods of process development i.e. strain, fermentor, fermentation parameters etc. Shake flask culture, inoculum development, and bioreactor design.

**Unit-II**

Strain development by mutagenesis, protoplast fusion and transformation of cloned genes. Recombinant protein expression with *E.coli* and fermentation. Expression in yeast *Pichia pastoris*, production of recombinant vaccines, purification of recombinant proteins.

**Unit-III**

Important microbial products and technology for production of beer, wine, microbial biomass lovastatin and related polyketides, lactam antibiotics and enzymes from industrial strains.

**Unit-IV**

General account of biotransformation, Immobilization of enzymes for production of HFCS, 6APA, Treatment of industrial effluents using activated sludge and anaerobic treatment options.

**Books Recommended :**

- 1 Manual Industrial Microbiology and Biotechnology (eds) A.L. Demain and Solomon, N. A. (1986). ASM, Washington. D.C.
2. Principles of Fermentation Technology Stansbury and Whittaker Pergamon Press.
3. Recombinant microbes for industrial and agricultural application (eds) Y. Murroka, T. Imanuka (1994) Marcel Dekker Inc.
4. Biotechnology 2 Edition W. Crueger and A. Crueger. (1992) Panima Publishers.
5. Microbial Technology. Vol I and II Eds. Peppler and Perlman, (1979) Academic Press.
6. Comprehensive Biotechnology Vol. III and IV ed. Moo Young (1984) Pergamon Press.

17  
**M.Sc. (FERMENTATION & MICROBIAL TECHNOLOGY)  
(SEMESTER-III)**

**FMT - 302 Environmental Biotechnology**

**Time: 3hrs**

**M. Marks: 80**

**Note:- The question paper will consist of 9 questions. Students will have to attempt 5 questions in total. -Question No. 1 will comprise of short answer questions covering the entire syllabus and will be compulsory. -Two questions to be set from each Unit and**

**Unit - I**

Purification of waste water by aerobic processes, Communal sewage and industrial effluents, Aims and limitations of aerobic bioprocessing. Activated sludge process. Trickling filter process, lagoon process. Purification of effluents by anaerobic processing. Biology of methane formation,.

**Unit-II**

Microbiology of cellulose degradation, Enzymatic aspects of cellulolysis. Potential application of Microbial cellulases. Microbiology of lignin degradation ,white-rot, brown-rot, and soft-rot type fungal attack in ligninolysis. Enzymology of lignin degradation and their biotechnological applications. Brief account of microbial degradation of pectin and hemicellulose with their potential applications.

**Unit-III**

The concept of Bioremediation efficacy testing approaches to bioremediation: Environmental modifications for Bioremediation, Microbial seeding and Bioengineering Approaches to the bioremediation of pollutants. Gaseous and Heavy metal air pollutants, Microbes as sources of Atmospheric pollutants, microbes as sinks for Bioscrubbers and biofilters.

**Unit-IV**

Microbial Insecticides: *Bacillus thuringiensis*. The concept of endotoxins and cry genes, *B. thuringiensis* as a present day bioinsecticide. (*Bacillus sphaericus*) *B. popilliae*) and Baculoviruses. Biology of baculoviruses, Baculoviruses as Insecticides and their future potential. Bacterial leaching from ores, microorganisms associated with recovery of copper by direct and indirect leaching, uranium leaching.

**Books Recommended:**

1. Atlas. R.M. and Bartha, M (1981). Microbial Ecology Fundamentals and applications, Addison-Wesley, Philipines.
2. Campbel, R. (1977). Microbial Ecology, Balckwell Scientific London.
3. Grant, W.D. and Long P.E. (1981). Environmental Microbiology, Balckie, London.
4. Bioreactors in Biotechnology: A practical approach (1991). Scragg. A.H. Ellis

Horwood Ltd. 17

18  
**M.Sc. (FERMENTATION & MICROBIAL TECHNOLOGY)  
(SEMESTER-III)**

**FMT- 303 Malting, Brewing and Enzyme Technology**

**Time: 3hrs**

**M. Marks: 80**

Note - The question paper will consist of 9 questions. - Question no. 1 will comprise of short answer questions covering the entire syllabus and will be compulsory. - Two questions to be set from each Unit and students will have to attempt one from each Unit.

**Unit-I**

Introduction: Brief Enzyme Overview, Classification & Nomenclature, General Characteristics. Kinetics of single substrate enzyme-catalysed reactions: Michaelis Menton Equation, Briggs- Haldane modification, Lineweaver-Burk plot, Eadie-Hofstee and Hanes plot.  $K_m$  and  $V_{max}$ , Inhibitors of Enzymatic Activity – Irreversible, Reversible, Competitive, Noncompetitive, Uncompetitive, substrate and allosteric inhibitors. Enzyme stability and activity - Effect of pH, temperature, water activity, freezing, ionic strength. Storage & Handling,

**Unit-II**

Analysis and composition of barley & malt sampling physical analysis, chemical, biochemical analysis, germination test, Suitability of different cereals for malting. Principles & technology for malting. Physiological and enzymatic transformations caused by malting. Brewing process and defects of beer.

**Unit-III**

Application of enzyme in food industries: enzymes in milk and cheese industry, baking industry, alcoholic beverages (wine and beer) and fruit juices, starch and sugar industries.

**Unit-IV**

Application of enzymes in drug industries: antibiotic and steroid production, enzyme therapy, enzymes in biosensors. Thermozymes, their mechanism of thermo stability and uses. Hybrid enzymes, Ribozymes and their uses.

**Recommended books:**

1. Palmer, T. and Philip, L. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry published by Horwood Publishing Group, Chichester, 2007.
2. Price, N. C. and Stevens, L. Fundamentals of Enzymology. The cell and molecular biology of catalytic proteins. 3<sup>rd</sup> edition. Published by Oxford University Press, 1999.
3. Pandey, A. Webb, C., Soccol C. R. and Larroche, C. Enzyme Technology. Published by Asiatech publishers INC. New Delhi, 2004.
4. Tucker G.A. and Tabor A.J. Enzymes in food processing. Springer publisher, 1995.
5. Moll, M. (1999) Brewing Science Vol I
6. Reed Gerald, Enzymes in food processing. Academic Press Inc; 2<sup>nd</sup> edition, 2005

**M.Sc. (FERMENTATION & MICROBIAL TECHNOLOGY)  
(SEMESTER-III)**

**FMT- 304 COMPUTERS PROGRAMMING AND BIOINFORMATICS**

**Time: 3hrs M. Marks: 80**

**Note for the Paper Setters. The question paper will be consisting of 3 sections as given below : -**

**Sections A:** (Total weightage 20 marks). This section will have 10 very short answer type questions. All questions will be compulsory. Each question will carry 1 marks. Questions are to cover the whole of syllabus.

**Section B:** (Total weightage 60 marks). This section will have eight questions. Two questions from each unit. The student will have to attempt four questions, one from each unit. Each question will carry 10 marks and its answers should not exceed 6 pages.

**Course Contents 1. Computer Basics :** Course introduction, MS Windows basics, UNIX basics, File Management, E-mail (PINE, EUDORA, Internet mail), File Transfer (ftp, WSftp).

**2. Computer Peripherals and Hardware Description :** Computer architecture, organization, Recognition and structure of different components of a computer system and their respective usage, I/O and storage devices with data communication and introduction of internet.

**3. Office Applications :** MS Office 2000/XP including MS Word, MS Excel, MS PowerPoint. **4.**

**The Virtual Library :** Searching MEDLINE on the Pubmed system from the National Centre for Biotechnology Information, Accessing full text journals on the internet, and printing articles.

**5. Some Useful Sites on the Internet :**

Databases (gene bank) and search tools and softwares at :

<http://www.ncbi.nlm.nih.gov>. Restriction enzyme site digestion Webcutter 2.0 at :

<http://www.firstmarket.com/cutter/cut2.html> Image analysis program :

<http://www.firstmarket.com/cutter/cut2.html> Image analysis program :

<http://www.scioncorp.com> PCR and Multiplex PCR : Guide and Troubleshooting

Guide : <http://www.info.med.yale.edu/genetics/ward/tavi/PCR.html> A Collection of WWW Links to Information and Services Useful to Molecular Biologists

<http://www.public.iastate.edu/~pedro/research.tools.html> <http://restools.sdsc.edu/>

[http://www.yk.rim.or.ip/~aisoa\\_i/tool.html](http://www.yk.rim.or.ip/~aisoa_i/tool.html)

**M.Sc. (FERMENTATION & MICROBIAL TECHNOLOGY)  
(SEMESTER-IV)**

**FMT – 403 Biostatistics**

**Time: 3hrs**

**Max. Marks : 80**

**Instructions to the paper setters: The question paper will be divided into 2 sections.**

**Sections A:** (Total weightage 20 marks). This section will have 10 very short answer type questions. All questions will be compulsory. Each question will carry 1 marks. Questions are to cover the whole of syllabus.

**Section B:** (Total weightage 60 marks). This section will have eight questions. Two questions from each unit. The student will have to attempt four questions, one from each unit. Each question will carry 10 marks and its answers should not exceed 6 pages.

**Unit-I Statistical Method:** Collection of data. Frequency distribution and its graphical representation. Measures of central tendency, dispersion, skewness and kurtosis moments.

**Probability:** Random experiments, sample space, events. Mathematical definition of probability of an event. Use of permutations and combinations in calculation of probability, Conditional probability. Additive and multiplication law of probability, random variables and its pmf, pdf, cdf, mathematical expectation and variances. Distribution of binomial, poisson and normal variables and their fittings only.

**Unit-II Correlation and Regression :** Relationship between variables, covariance, Karl-Pearson's correlation coefficient, Spearman's rank correlation coefficient, interpretation of correlation coefficients. Least square technique for regression lines (without proof), regression coefficients, relationship between correlation analysis and regression analysis.

**Unit-III Hypothesis Testing :** Sample statistics and parameters, population null hypothesis, level of significance. Definitions of Chi-square test, 't' and 'f' varieties and their Pdf 3 only, Application of X<sup>2</sup>-t and F in testing of hypothesis.

**Unit-IV Analysis of Variance :** Meaning of analysis of variance with linear models. Analysis of variance for one-way classified data, analysis of variance for two-way classified data with one observations for cell, analysis of variance for two-way classified data with multiple but equal number of observation per cell (data analysis only).

**Suggested Reading Material**

1. Hussain.I. et.al. Mathematics, A text book for class XI, NCERT.
2. Joshi, D.D. et.al. Mathematics, A text book for class XII, NCERT.
3. Batschelet, Mathematics for life Sciences
4. S. Sokal, R. and James F. Introduction to Biostatistics.

21  
**M.Sc. (FERMENTATION & MICROBIAL TECHNOLOGY)  
(SEMESTER-III)**

**P1- FMT Industrial and Environmental Biotechnology**

**Lab Time: 4hrs**

**M. Marks: 100**

1. Microbial biodiversity of different ecosystems. 2. To study the effect of different sugar and NaCl concentration on yeast growth. 3. Effect of different temperatures on yeast growth. 4.

Isolation of N

fixing bacteria. Nitrifying and denitrifying bacteria. 5. Soil Enrichment Technique. 6. Isolation of cellulase producing fungi. 7. Differentiation of white-rot and brown-rot fungi. 8. To study the BOD & COD levels of different water systems. 9. Bacteriological analysis of water by presumptive, confirmatory and completed tests. 10. Screening industrially important microorganisms from soils, food processing wastes, animal droppings. 11. To evaluate the production of alcohol from molasses & lignocellulosics. 12. Microbial biomass production (fungi/bacteria/yeast) batch and continuous culture. 13. To compare production of citric acid using sucrose and molasses as carbon source. 14. Production of lactic acid using cheese whey as substrate. 15. Production of extracellular enzymes (pectinase and xylanase) by thermophilic and mesophilic fungal culture. 16. To isolate rare genera of microorganisms for novel antibiotic production, and to evaluate the potential of different media for antibiotic production. 17. To study the protoplasting and regeneration in fungi. 18. Isolation of fungi genomic DNA and plasmid DNA by mini prep protocol. 19. To study the role of plasmid in degradation of xenobiotic compounds and curing of plasmid. 20. PCR amplification of DNA from natural sources. 21. Purification of xylanase/ any extracellular enzyme by Ion exchange/gel filtration chromatography and SDS-PAGE to ascertain the purity of the protein.

**M.Sc. (FERMENTATION & MICROBIAL TECHNOLOGY)  
(SEMESTER-IV)**

**FMT 402 Recent Advances in Fermentation Techonology Time: 4hrs M. Marks: 100**

The syllabus for this paper will consist of topics of current research. Every year the scientific articles will be selected from leading journals, reviews and books.

