Master of Science
in
FOOD AND INDUSTRIAL MICROBIOLOGY

PROGRAMME STRUCTURE AND SYLLABUS
2019-20 ADMISSIONS ONWARDS

(UNDER MAHATMA GANDHI UNIVERSITY PGCSS REGULATIONS 2019)

EXPERT COMMITTEE IN MICROBIOLOGY (PG)
MAHATMA GANDHI UNIVERSITY

2019

Acknowledgement

Successful preparation of this syllabus required a lot of guidance and assistance from Mahatma Gandhi University Vice Chancellor and members of the Syndicate. I am extremely privileged to have their support all along the completion of the syllabus. I also acknowledge the financial support received from the University.

I respect and thank Syndicate Members Sri. V. S. Praveen Kumar, Dr.Aji C. Panicker and Dr. K. Krishnadas, for providing me an opportunity to chair the Expert Committee and giving us all support till the submission of the completed syllabus. I appreciate the support rendered to the expert committee by the staff of University Section Ac A IX, especially Sri. Anandlal Ben.

I owe deep gratitude to all the expert committee members, who took keen interest, till the completion of the syllabus preparation by providing all the necessary information required for the improvement of the syllabus. I also acknowledge the support received from the teachers, research scholars, students and industrialists who actively participated in the discussions during the curriculum restructuring and syllabus revision work shop. I gratefully acknowledge their valuable contribution.

I heartily thank the Principal, Staff and Management of Sree Sankara College, Kalady for providing support during the curriculum restructuring and syllabus revision work shop. Let me not forget to mention the support received from Students and Staff of Postgraduate and Research Department of Microbiology for organising the curriculum restructuring and syllabus revision work shop.

Chairman
Expert Committee, Microbiology (PG)

THE EXPERT COMMITTEE IN MICROBIOLOGY (PG)

Chairperson:

Dr.S Mohan, Assistant Professor, Department of Microbiology, Sree Sankara College, Kalady

Members:

1. Dr.Soorej M Basheer, Assistant Professor and Head of the Department of Molecular Biology, Kannur University. Nileeswaram Campus.
2. Dr.Manjula R, Associate Professor, Department of Microbiology, Sree Sankara College, Kalady
3. Dr.Valsa A K, Associate Professor, Department of Microbiology, Sree Sankara College, Kalady
4. Dr.Sudha K., Assistant Professor, Department of Biotechnology, St. Peter's College, Kolencherry
5. Dr. Ally C. Antony, Assistant Professor, Department of Biotechnology, MES College, Marampilly, Aluva
6. Dr.Manjusha K., Assistant Professor, Department of Microbiology, St. Xavier's College for Women, Aluva
7. Mr. Noby Mathew, Assistant Professor, Department of Applied Microbiology, St. Thomas College, Pala.
8. Mr. Sreejith K M., Senior Manager –QA, Innovative Foods Ltd., Ezhupunna P O., Aleppey 688537.
9. Mr. Manoj Mathew, Manager –QC, AVT McCormick Ingredients Pvt Ltd., Marampilly P O., South Vazhakulam, Aluva, Ernakulam 683105.

TABLE OF CONTENTS

M. Sc. Food and Industrial Microbiology Programme

(Mahatma Gandhi University Regulations PGCSS-2019 from 2019-20 Academic Year)

1. Aim of the Programme:

Microbiology deals with the study of microbes. The M.Sc. Degree programme aims at providing an in depth understanding of the biochemistry, cell biology, molecular biology and physiology of microbes and their experimental aspects. This programme also aims to study emerging areas of Bioscience along with analytical techniques, bioinformatics and biostatistics. At the end of the program, the students need to achieve the program specific outcome listed below.

Program Specific Outcome

Food Microbiology is the study of microorganisms that inhabit, contaminate or spoil foods. Though the major concern in food microbiology is the emergence of foodborne diseases and their surveillance and control, the subject also deals with the advantages of microorganisms in the industrial production of metabolites, food products, vaccines, antibiotics and the like. In industrial microbiology the immediate motivation is profit and the generation of wealth where large scale production of metabolites, food products, therapeutics are dealt with. There is good scope for this subject both in India and abroad since a number of companies and research avenues are exploring this subject in the broadest sense. As such food and industrial microbiology, when dealt together, may enable participants to study large-scale and profit-motivated production of microorganisms or their products for direct use, or as inputs in the manufacture of other goods. The participantswill gather an in depth knowledge of the recent techniques in this area and also get introduced to the methodology of systematic academic lifewhich will enable them to lay a firm foundation in every aspect of food and industrial microbiology and to explain a broad spectrum of modern trends in the respective disciplines to develop experimental, observative and computational skills. This course will createpotent candidates capable enough to take up challenging positions in food industries, R&D organizations and analytical laboratories in India and abroad.

By joining this PG Programme the students are expected to

i. understand the importance and scope of the discipline
ii. inculcate interest and love for nature with its myriad living forms, particularly the miniature ones
iii. impart knowledge of Science as the basic objective of education

iv. develop a scientific attitude and an ability to work on their own so as to make them fit for the society

v. develop skill in experimental design, use of equipments, interpretation and analysis of data

vi. develop ability for the application of the acquired knowledge in day to daylife

vii. build up professionals in food analysis, teaching and R&D work

viii. formulate new technologies and newer food products and its extension to industry level

ix. emerge as successful entrepreneurs

2. Eligibility for Admissions

Minimum 50% marks in Graduation in Zoology, Botany, Chemistry, Biochemistry, Bioinformatics, Microbiology, Industrial Microbiology, Biotechnology, Food Technology & Quality Assurance, Food Science & Quality Control or any other discipline in Life Sciences viz., Environmental Sciences, Biophysics, Fishery Science, Clinical Nutrition & Dietetics, and Food Service Management and Dietetics

The admission to M Sc.Food and Industrial Microbiology PG Programme shall be as per the rules and regulations of the university.

3. Medium of Instruction and Assessment

The medium of instruction and assessment will be English.

4. Faculty under which the Degree is Awarded

Faculty of Science.

5. Specializations offered, if any

Food and Industrial microbiology

6. Note on compliance with the UGC Minimum Standards for the conduct and award of Post Graduate Degrees

The programme structure and syllabus of M Sc.Microbiology complies with the minimum standards prescribed by the University Grants Commission. The M Sc.Microbiology programme is under the Credit Semester Scheme, consisting of four semesters spread over a period of two years.

- Total credits are 80.
- Number of courses: Core courses - 12, Elective courses - 3, Laboratory courses – 4
- Evaluation: Internal assessment and external evaluation - 1:3 ratio.

- Grading: Direct grading system on a 7 point scale.

THE PROGRAMME STRUCTURE

Course Code	Title of the Course	Type of the Course	Teaching hrs/week	Credits

FIRST SEMESTER				
MG020101	General Microbiology	Core course	4	4
MG020102	Principles of Biochemistry	Core course	4	4
MG020103	Microbial Physiology, Metabolism and Genetics	Core course	4	4
MG020104	Food Chemistry	Core course	3	3
MG020105	Laboratory Course I	Core course	10	4
	Total		**25**	**19**
SECOND SEMESTER				
MG020201	Bioanalysis and Instrumentation	Core course	4	4
MG020202	Fermentation Technology	Core course	4	4
MG020203	Molecular Biology and Genetic Engineering	Core course	4	4
MG020204	Food and Microorganisms	Core course	3	3
MG020205	Laboratory Course II	Core course	10	4
	Total		**25**	**19**
THIRD SEMESTER				
MG020301	Microbial Processes and Products	Core course	4	4
MG020302	Microbial Spoilage and Preservation of Foods	Core course	3	3
	Food Packaging Technology	Elective -1	4	4
	Basics of Environmental Science			
	Medical Microbiology			
	Nutraceuticals	Elective -2	4	4
	Enzyme Technology and Biosensors			
	Fundamentals of Immunology			
MG020303	Laboratory Course III	Core course	10	4
	Total		**25**	**19**
FOURTH SEMESTER				
MG020401	Food quality and Food borneDiseases	Core course	4	4
MG020402	Biostatistics and Research Methodology	Core course	4	4

	Biosafety, IPR and Patents	Elective -3	4	4
	Microbial Ecology			
	Dairy Microbiology			
MG020403	Laboratory Course IV	Core course	13	5
MG020404	Project		-	4
MG020405	Comprehensive Viva-voce		-	2
	Total		**25**	**23**
Total Credits				**80**

GROUPS OF ELECTIVES

Semester	GROUP A (MG83)	GROUP B (MG84)	GROUP C (MG85)
Third Semester	MG830301 Food Packaging Technology	MG840301 Basics of Environmental Science	MG850301 Medical Microbiology
Third Semester	MG830302 Nutraceuticals	MG840302 Enzyme Technology and Biosensors	MG850302 Fundamentals of Immunology
Fourth Semester	MG830403 Biosafety, IPR and Patents	MG840403 Microbial Ecology	MG850403 Dairy Microbiology

SYLLABUS

First Semester

M. Sc. Food and Industrial Microbiology

MG020101	General Microbiology
MG020102	Principles of Biochemistry
MG020103	Microbial Physiology, Metabolism and Genetics
MG020104	Food Chemistry
MG020105	Laboratory Course I

MG020101 - GENERAL MICROBIOLOGY

Teaching Hours/week: 4 **Credits: 4**

Course Outcome:

By attending the course, the students will be able to:

1. Understand basic microbial structure and function
2. Analyze and interpret results from a variety of microbiological methods and to apply these methods to analogous situation.
3. Master laboratory skills in Microbiology.
4. Demonstrate that microorganisms have an indispensible role in the environment.

Module 1 :An overview of Microbial World (10 Hrs)

History of Microbiology- Branches of Microbiology-Scope of Microbiology- Contributions of early microbiologists - Microbial diversity - Difference between Eubacteria and Archaebacteria - Prokaryotes and Eukaryotes

Module2 : General Properties of Microorganisms (20 Hrs)

Morphology and structure of bacteria - Surface structures and inclusions of bacteria – Viruses : unique properties, morphology and structure - - Viral replication – Culture of viruses - Viral diversity: bacterial, plant and animal viruses - Viroids and Prions - Fungi – Properties and classification – General characters of Yeasts, Algae, Protozoa

Module 3 :Sterilisation Techniques (15 Hrs)

Sterilisation - Principles and methods, physical and chemical methods – Disinfectants: modes of action - Testing of disinfectants – Antibiotics: mechanism of action, classification - Drug resistance in bacteria - Antibiotic sensitivity tests.

Module4 :Culturing and Characterization (20 Hrs)

Factors influencing microbial growth - Environmental and nutritional factors - Nutritional types of bacteria - Chemotaxis, Phototaxis and other taxes - Cultivation of bacteria - culture media and methods - Types of media - Pure culture techniques : Serial dilution, Streak plate, Pour plate, Spread plate - Anaerobic culture methods - Maintenance and transport of cultures - Identification of bacteria - Staining Techniques - Cultural, physiological and biochemical properties - Molecular methods for identification

Module5 : Bacterial Taxonomy (15 Hrs)

Principles of bacterial taxonomy - Molecular methods in taxonomy - DNA finger printing methods - RFLP, RAPD, STRR & LTRR, REP, ERIC –PCR - Ribotyping - Ribosomal RNA

sequencing and characteristics of primary domains - rRNA :Types of rRNA- 23s rRNA, 16S rRNA& 5S rRNA - Importance of 16SrRNA in microbial identification and taxonomy- Intraspecies classification of bacteria - Phylogenetic and numerical taxonomy -

Reference Books

1. Dubey RC and Maheswari DK (2005). A text book of Microbiology, Revised Multicolour edition, S.Chand Publishers, New Delhi.

2. Purohit SS (2005). Microbiology - Fundamentals and Applications. Student Edition Publishers, Jodhpur.

3. Pelczar&Kreig (2006). Microbiology5th edition. Tata McGraw Hill, New Delhi

4. Powar&Daginawala (2005). General Microbiology Vol.I& II 8th Edition, Himalaya Publishing House, Mumbai.

5. Salle, AJ (2001). Fundamentals & Principles of Bacteriology. 7th edition. Tata McGraw-Hill, Davis, Delbecco, Eisen& Ginsburg (1990) Microbiology 5th Edition Harper &raw, New York

7. Gerhardt, Murray, Wood and Kreig 1994. Methods for General and Molecular Bacteriology, ASM Press, Washington.

8. Alexopoulus CJ and C W. Mims.(1993).Introductory Mycology (3rd edition) WileyEastern Ltd, New Delhi.

9. Elizabeth Moore-Landecker. (1996). Fundamentals of the fungi.(4th edition). PrenticeHall International, Inc, London.

10. Conrat HF, Kimball PC and Levy JA. (1988). Virology. II edition. Prentice Hall, Englewood Cliff, New Jersey.

11. Roger Hull (2002). Mathews' Plant Virology. (4thEdition).Academic press-A Harcourt Science and technology company, New York.

MG020102 – PRINCIPLES OF BIOCHEMISTRY

Teaching Hours/week: 4 **Credits: 4**

Course Outcome:

By attending the course, the students will be able to:

1. Understand the basic concepts related to enzymes.
2. Study the structure and function of biomolecules.
3. Understand various metabolic pathways and regulation of biochemical processes.
4. Apply the theoretical basis to carry out experiments.

Module1 : Composition of Living Matter (10 Hrs)

Biochemistry of bacterial, animal and plant cell, specialized components of microorganisms and their structure and function.

Module2 :Structural Features and Chemistry of Macromolecules (20 Hrs)

Nucleic acids, proteins, carbohydrates and lipids - biomolecules such as antibiotics, vitamins, pigments,Microbial secondary metabolites

Module3: Overview of Metabolism (20 Hrs)

Metabolism of biomolecules – carbohydrates (glycolysis, gluconeogenesis, PPP, glycogen metabolism, Kreb's cycle) ETC and Oxidative phosphorylation, lipids (Synthesis and degradation of fatty acids), amino acid (Transamination, synthesis and degradation of glycine and serine) and nucleic acids (synthesis and degradation of purines and pyrimidines)- hormone regulation of metabolism with specific reference to insulin and glucagon.

Module 4 : Bioenergetics (15 Hrs)

Flow of energy through biosphere - strategy of energy production in the cell - oxidation reduction reactions - coupled reactions and group transfer - ATP production - structural features of biomembranes - membrane transport - free energy and spontaneity of reaction and equilibrium - basic concepts of acids, base, pH and buffers.

Module 5:Enzymes as Biocatalysts (15 Hrs)

Enzymes as biocatalysts - enzyme classification, specificity, active site, activity unit, isozymes - Enzyme kinetics: Michaelis–Menton equation for simple enzymes - determination of kinetic parameters, multistep reactions and rate limiting steps - enzyme inhibition, allosterism, kinetic analysis of allosteric enzymes, principles of allosteric regulation – Ribozymes - Abzymes

Reference Books

1. Biochemistry, Stryer edition W.H. Freeman.

2. Principles of Biochemistry, Lehninger, by Nelson and Cox.

3. Nelson, D.L. and Cox, M.M. (2005), Lehninger Principles of Biochemistry, Freeman and Company, NewYork.

4. Conn E.E., Stumpf P.K., Bruening G. and Doi R.H. (1997,) Outlines of Biochemistry. John Willey and Sons Inc. New York and Toronto.

5. Voet D., Voet J.G. and Pratt C.W. (1999), Fundamentals of Biochemistry, John Wiley and Sons Inc., New York.

6. Elliott W.H. and Elliott D.C. (1997), Biochemistry and Molecular Biology. Oxford University Press Inc. New York.

7. Metzler D.E. (2001), Biochemistry (Vol I and II) Academic Press, London and New York.

8. Berg J.M., Tymoczko J.L. and Stryer L (2002), Biochemistry, W.H. Freeman Publishers, New York.

MG020103 – MICROBIAL PHYSIOLOGY, METABOLISM AND GENETICS

Teaching Hours/week: 4 **Credits: 4**

Course Outcome:

By attending the course, the students will be able to:

1. Understand the structural and metabolic diversity of microorganisms.
2. Understsand genetic and physiological regulation in microorganisms.
3. Understand the concept of microbial metabolism
4. Know the concepts of molecular basis of mutation and repair mechanisms.

Module1 : Bacterial Physiology (20 Hrs)

Bacterial growth - Growth cycle - Binary fission – Fragmentation – conidia formation - Generation time - Bacterial growth curve – quantitative enumeration of bacterial growth - Microbial growth at different temperature, pH and oxygen level - Bacterial respiration- Aerobic : Glycolysis,ED pathway,Krebs cycle - HMP - PPP - Glyoxylate pathway - Oxidative phosphorylation and ATP formation - Anaerobic : Fermentation - Alcoholic - Lactic- : Homolactic, heterolactic - Acetic - Propionic

Module2 : Bacterial Photosynthesis (15 Hrs)

Photosynthetic microorganisms, photosynthetic pigments, and generation of reducing power by cyclic and non-cyclic photophosphorylation, electron transport chain in photosynthetic bacteria, Carbon dioxide fixation pathways.

Module3 : Bacterial Permeation (10 Hrs)

Structure and organization of cell membrane; Structure of peptidoglycan; Structure of Gram positive and Gram negative cell wall, Cell cycle of *E. coli, Yeast, S. cerevisiae,* Stationary phase in *E. coli* etc. Transport systems across membrane -active and passive transport.

Module4 :Bacterial Genetics (20 Hrs)

Bacterial Chromosome - Extra-chromosomal genetic elements and their inheritance Genetic recombination - Conjugation - Transduction - Transformation - Methods of gene mapping - – Transposons: Insertion sequences and composite transposons, phages as transposons, replicative, non-replicative and conservative transposition - Regulation of gene expression in prokaryotes **:** Operon concept, co-ordinated control of structural genes, positive regulation in *E.coli* (Arabinose operon) and negative regulation in *E.coli* (lac operon), inducers and repressors, regulation by attenuation by trp operon.

Module5 :Mutation and Repair (15 Hrs)

Molecular basis of mutations - physical and chemical mutagenic agents - types of mutation – Mutagenic agents - Environmental mutagenesis – Site directed mutagenesis - toxicity testing and population genetics - Systems that safeguard DNA - DNA methylation and DNA repair mechanisms - excision, mismatch, SOS, photo-reactivation, recombination repair and glycocyclase system.

Reference Books

1. Caldwell D.R. (1995), Microbial Physiology and Metabolism, Brown Publishers.
2. Moat A.G. and Foster J. W. (1999), Microbial Physiology. Wiley.
3. Brun. Y.V. and Shimkets L.J. (2000), Prokaryotic Development. ASM Press.
4. Advances in Microbial Physiology. Volumes. Edited by By A.H. Rose. Academic Press, New York.
5. Applied Microbial Physiology by Rhodes.
6. Biosynthesis by Smith.
7. The Bacteria. Volumes by I.C. Gunsalus and RogeryStanier, Acadenic Press.
8. Microbial Physiology by Benjamin

MG020104 – FOOD CHEMISTRY

Teaching Hours/week: 3 **Credits: 3**

Course Outcome:

By attending the course, the students will be able to:

1. Explain the properties and reactions of carbohydrates, lipids and proteins during storage and processing of foods and the effect of these on the quality and property of foods.
2. Give an account of the main factors influencing the colour anf flavour of food.
3. Understand the composition of foods and the effect of these factors on foods.
4. Study large scale and profit motivated production of microorganisms or their products for direct use or as inputs in the manufacture of other products.

Module1 : Introduction to Chemistry of Foods : Carbohydrates (15 Hrs)

Composition and factors affecting composition of foods - Moisture in foods and determination of moisture - Carbohydrates - Chemistry of cellulose, starches, other polysaccharides - starch enzymes, Gel formation and starch degradation - Pectic substances, their occurrence structure, properties and use in foods - Plant acids, acidity, taste

Module 2 :Chemistry of Amino Acids and Proteins (12 Hrs)

Classification of proteins, physical and chemical properties of proteins, functional properties of proteins in foods, hydrolysis of proteins - Major food - Proteins and their sources, Changes in proteins during processing - Determination of Proteins,

Module 3 : Chemistry of Oils and Fats (13 Hrs)

Physical and chemical properties of fats, rancidity and flavour reversion, processing of oil bearing materials, refining of oils and fats, fat hydrolysis and inter-esterification, hydrogenation, shortenings and spreads - Emulsions, Definition, surface activity, surface film theory of emulsions, properties and types of emulsions, emulsifying agents, their chemistry during processing - Essential oils, Chemistry of occurrence, Extraction - Terpene oils and their use in foods

Module4 :Chemistry of Cereals, Pulses and Oil Seeds (12 Hrs)

Cereals: Cereal varieties and their suitability for processing - Structure of wheat, rice - Chemical compositions and nutritional values of prominent cereals (Wheat, rice, corn, barley, sorghum, oats)- Distribution of vitamins, proteins, minerals, carbohydrates and fats in different grains

Pulses: Nutritional value of prominent pulses (Moong, Redgram, lentil, black gram and soyabeans)

Oilseeds: Chemical composition and nutritionalvalue of prominent oilseeds (Sunflower mustard, cotton seed, ground nut, cashewnut and coconut) – Distribution of vitamins, proteins, minerals, carbohydrates and fats in different oilseeds

Module5 :Chemistry of Food Processing (8 Hrs)

Browning Reactions in Foods, Nonenzymatic Browning, Pigment Formation, Melanoidin - Maillard Polymers, Caramelization, Ascorbic Acid Oxidation, Antioxidant Activity of Nonenzymatic Browning Products, Inhibition of nonenzymatic browning

Reference Books

1. Food Science and experimental foods, Swaminathan, N. (1987) Ganesh Publications, Madras.

2. Food chemistry, Meyer L.M.(1969) Van Noustrand Reinhold co., New York.

3. Foundations of Food Preparation, Peckham, C.G. (1979),The Macmillan co., London.

4. Food Theory and Applications, Paul P.C. and Palmer H.H. (1972), John wiley and Sons, New York.

5. The experimental study of foods, Griswald R.M. (1962), Houghton, Muffin Co., New York.

6. Introductory foods, Bennion M. and Hughes, D. (1975), Macmillan publishing Co., New York.

7. Food facts and principles, SakuntalaManay and shadaksaraswamy, M (1987) Allied Publishers, New Delhi.

MG020105 – LABORATORY COURSE I

Lab Hours/week: 10 Credits: 4

Course Outcome:

By attending the practical, the students will be able to:

1. Understand the principles of sterilization and disinfection
2. Learn the principles and working of equipments used in microbiology
3. Isolate and culture bacteria and fungi
4. Identify bacteria based on staining and biochemical reactions
5. Qualitatively analyse and identify biomolecules
6. Estimate and quantify nucleic acids, proteins, lipids

Experimental Design

1. Microscopy- Bright field, dark field and phase contrast microscopy
2. Micrometry - Calibration of ocular micrometer - measurement of fungal spores, yeast cells and bacteria.
3. Sterilization methods
4. Preparation of nutrient media
5. Staining methods - Simple staining, Capsular staining - Special staining : Staining of metachromatic granules, Spore staining, Acid fast staining
6. To see if bacteria are motile by Hanging drop technique
7. Pure culture techniques : serial dilution, Streak plate, Pour plate, Spread plate Growth characteristics of bacteria
8. Cultivation of bacteria and fungi
9. Study of cultural characteristics and biochemical reaction of bacteria
10. Lactophenol cotton blue staining of fungi
11. Testing of disinfectants
12. Antibiotic sensitivity tests- disc diffusion, MIC
13. Determination of microbial number, generation time
14. Factors influencing bacteria : pH, Temperature
15. Anaerobic culture methods
16. Methods of microbial culture preservation.
17. Systematic identification of biomolecules – Qualitative tests for amino acids and protein - Biuret test, Millon's test, Nitroprusside test, Ninhydrin test, Sakaguchi test.
18. Qualitative test for carbohydrates - Molisch’s test, Bial’s test, Benedicts test, Barfoeds test, Fehlings test, Seliwanof’s test, Mucic acid test, Iodine test.
19. Qualitative test for Lipids - acrolein test, test for saturation, test for unsaturation, saponification test
20. Qualitative test for NPN substances - Urease test, Phosphotungstic acid test, Jaffes test, Uric acid test.

21. Quantitative tests for carbohydrates proteins and nucleic acids - Detection and estimation of lipids.
22. Preparation of solutions: Percentage solutions, Molar solutions, Normal solutions, Dilution of Stock solutions

SYLLABUS

Second Semester

M. Sc. Food and Industrial Microbiology

MG020201	Bioanalysis and Instrumentation
MG020202	Fermentation Technology
MG020203	Molecular Biology and Genetic Engineering
MG020204	Food and Microorganisms
MG020205	Laboratory Course II

MG020201 – BIOANALYSIS AND INSTRUMENTATION

Teaching Hours/week: 4 **Credits: 4**

Course Outcome:

By attending the course, the students will be able to:

1. Demonstrate instrumental techniques for the separation and analysis of macromolecules.
2. Understand the particle and wave property of electromagnetic radiation.
3. Master the techniques and instruments used in the laboratory and thereby develop experimental, observational and computational skills.
4. Understand and demonstrate advanced microscopic techniques.

Module1:Basic Laboratory Instruments, Centrifugation and Chromatography (20 Hrs)

Principle and working of pH meter, Laminar-air flow. Centrifugation: Types of centrifuge machines, preparative and analytical centrifuges, differential centrifugation, sedimentation velocity, sedimentation equilibrium, density gradient methods and their applications – Chromatography - Theory, principles and applications of paper, thin layer (TLC, HP-TLC), gel filtration, ion exchange, affinity, hydrophobic, gas liquid (GC), high pressure/ performance liquid chromatography (HPLC) – MALDI-TOF

Module 2:DNA amplification, Electrophoresis and Blotting Techniques (20 Hrs)

Basic principles of electrophoresis - theory and application of paper, starch gel, Agarose gel - native and denaturing PAGE - 2-Dimensional polyacrylamide gel electrophoresis and their uses in protein research - isoelectric focusing - Polymerase Chain Reaction - basic principle - Modified PCR (Nested PCR, Inverse PCR, Touchdown PCR, Anchored PCR, PCR for mutagenesis, asymmetric PCR, RT PCR, Real Time PCR, PCR walking) - Gene cloning Vs. Polymerase chain reaction - Applications of PCR in biotechnology – Expressed sequence tagging (EST) - Fluorescent in situ hybridization (FISH) -Blotting techniques : Southern, Northern and Western blot

Module3 :Colorimetry and Spectroscopy(15 Hrs)

Principles of colorimetry: verification of Beer's law, estimation of a selected protein, finding out Imax, relation between O.D. and percentage transmission - Isolation and quantification of DNA from microorganisms or other sources - Spectroscopic techniques, theory and applications of Uv, Visible, IR, NMR and Use of NMR in elucidation biosynthesis pathways - Fluorescence, Atomic Absorption, CD, ORD, Mass, Raman Spectroscopy

Module4 :Radioisotopic techniques(10 Hrs)

Use of radioisotopes in life sciences, radioactive labelling, principle and application of tracer techniques, detection and measurement of radioactivity using ionization chamber, proportional chamber, Geiger- Muller and Scintillation counters, autoradiography and its applications - Dosimetry

Module 5 : Microscopic Techniques(15 Hrs)

Microscopy - Resolution - Magnification - Principles and Applications of Light, Phase Contrast, Fluorescence Microscopy - Electron Microscopy : SEM and TEM - Specimen preparation for Electron Microscopy - Confocal microscopy - Flow Cytometry

Reference Books

1. Instrumental Methods of Analysis. 6th Edition by H.H. Willard, L.L. Merritt Jr. And others. 1986. CBS Publishers and Distributors.

2. Instrumental Methods of Chemical Analysis. 1989 by Chatwal G and Anand, S. Himalaya Publishing House, Mumbai.

3. A Biologists Guide to Principles and Techniques of Practical Biochemistry. 1975 by Williams, B.L. and Wilson, K.

4. Spectroscopy. Volume 1. Edited by B.B. Straughan and S. Walker. Chapman and Hall Ltd.

5. Gel Electrophoresis of Proteins- A Practical Approach by Hanes.

6. Chromatography: Concepts and Contrasts- 1988 by James Miller. John Wiley and Sons. Inc., New York.

7. Analytical Biochemistry by Holme.

8. Introduction to High Performance Liquid Chromatography by R. J. Hamilton and P. A. Sewell.

9. Spectroscopy by B.P. Straughan and S. Walker.

10. Practical aspects of Gas Chromatography and Mass Spectrometry 1984 by Gordon M. Message, John Wiley and Sons, New York.

11. Gel Chromatography by Tibor Kremmery. Wiley Publications.

12. Isotopes and radiations in Biology by C.C. Thornburn, Butterworth and Co. Ltd., London.

13. The use of radioactive isotopes in the life sciences by J.M.Chapman and G.Ayrey, George Allen and Unwin Ltd., London.

MG020202 – FERMENTATION TECHNOLOGY

Teaching Hours/week: 4 **Credits: 4**

Course Outcome:

By attending the course, the students will be able to:

1. Study various upstream, downstream processes and product recovery.
2. Understand the design and application of fermentor/bioreactor.
3. Demonstrate the production of microbial products.
4. Understand and explain the science underlying the conversion of raw materials to final products.
5. Evaluate the quality of raw materials and their influence on the properties of final products.

Module 1 : Fermentation (10 Hrs)

An introduction to fermentation processes - the range of fermentation processes – Types of culture : batch culture, synchronous culture, continuous culture, fed-batch culture, applications and examples - Multistage systems – Feed back systems - Solid substrate fermentation - Instrumentation and control –Scale up of fermentation processes

Module2 :Strain Improvement (15 Hrs)

Microorganisms used in industrial microbiological processes - Isolation, preservation and strain improvement of industrially important microorganisms - Screening methods - Isolation of autotrophic mutants - Use of recombinant DNA technology and protoplast fusion techniques for strain improvement of primary and secondary metabolites - Production of recombinant molecules in heterologous system - Preservation of cultures after strain improvement programme - Inoculum development for large scale bioprocesses

Module3 :Fermenter Design (20 Hrs)

Design of a basic fermenter, bioreactor configuration, design features, individual parts, baffles, impellers, foam separators, sparger, culture vessel, cooling and heating devices, probes for online monitoring, computer control of fermentation process, measurement and control of process. Reactors for specialized applications: Tube reactors, packed bed reactors, fluidized bed reactors, cyclone reactors, trickle flow reactors, their basic construction and types for distribution of gases.

Module4 : Fermentation Media (15 Hrs)

Media and materials required for industrial microbiological processes - sources, formulation, antifoams and optimization - Media for industrial fermentation - Criteria used in media formulation - Sterilization and influence of medium - Raw materials for process control - Development of inoculums for industrial fermenters - Sterilization of fermenter and feeds

Module5 : Processes for Recovery of Products (20 Hrs)

Biomass separation by centrifugation, filtration, flocculation and other recent development - Cell disintegration: Physical, chemical and enzymatic methods - removal of microbial cells and solid matter - Foam preparation – precipitation - chromatography – distillation -. Adsorption processes and Concentration by precipitation - ultra-filtration - reverse osmosis - Drying and crystallization.

Reference Books

1. Biotechnological Innovations in Chemical Synthesis. BIOTOL. Publishers / Butterworth - Heinemann.
2. Industrial Microbiology by G. Reed (Ed), CBS Publishers (AVI Publishing Co.)
3. Biology of Industrial Microorganisms by A.L. Demain.
4. Genetics and Biotechnology of Industrial Microorgansims by C.l. Hershnergey, S.W. Queener and Q.Hegeman. Publisher. ASM.
5. Ewesis*et al* 1998. Bioremediation Principles. Mac Graw Hill.
6. Annual Reports in Fermentation Processes by D. Pearlman, Academic Press.
7. Fundamentals of Biochemical Engineering by Bailey and Ollis.
8. Annual Review of Microbiology by Charles E. Cliffton (Volumes)
9. Biotechnology, A textbook of industrial Microbiology by Creuger and Creuger, Sinaeur associates.
10. Manual of industrial Microbiology and Biotechnology 2nd edition by Davis J.E. and Demain A.L. ASM publications

MG020203–MOLECULAR BIOLOGY AND GENETIC ENGINEERING

Teaching Hours/week: 4 **Credits: 4**

Course Outcome:

By attending the course, the students will be able to:

1. Understand the concepts of microbial genome.
2. Explain the emergence of mutations and new gene variations.
3. Understand the concepts, methods and applications of rDNA technology.
4. Independently execute laboratory experiments using standard methods and techniques in molecular biology, with the appropriate analysis and interpretation of results.

Module1 : Isolation, Sequencing and Synthesis of Genes(20 Hrs)

Replication – Transcription – Translation - Methods of gene isolation - Construction and screening of genomic and cDNA libraries, Chromosome walking, Chromosome jumping, transposon tagging, Map based cloning - DNA sequencing Techniques (Maxam Gilbert's chemical degradation methods and Sanger's dideoxy chain termination method) - Automated DNA sequencing - Advanced sequencing procedures – pyrosequencing, Illumina, ABI / SOLID and their applications - Organochemical gene synthesis.

Module2 :Cloning and Expression Vectors(20 Hrs)

Vectors for *E coli* with special reference to plasmid vectors (pSC101, pBR322, pUC, their development, features and selection procedures), direct selection plasmid vectors, low copy number plasmid vectors, runaway plasmid vectors, Bacteriophages (λ and M13) with special reference to Charon phages, λEMBL, λWESλB', λ ZAP- their development, features, selection procedures, *in vitro* packaging mechanisms, cosmids, features, advantages and cosmid cloning schemes, phagemids with special reference to pEMBL, pBluescript, pGEM3Z, pSP64, pcDNA, pLITMUS - Binary and shuttle vectors - Construction of genomic libraries and cDNA libraries, procedures for recombinant selection and library screening

Module3 :Recombinant DNA Technology (15 Hrs)

History of rDNA technology - Gene cloning – Bacterial Transformation - Nucleases – Polymerases – Ligases – other DNA modifying enzymes - Topoisomerases – Restriction endonucleases - modification of restriction fragments - TA cloning and homopolymertailing - Restriction mapping - Construction of chimeric DNA - Addition of poly A and poly T tails - Ligation : blunt end and staggered end – Linkers - Adaptors

Module4 : Genomics and Proteomics (15 Hrs)

Basic principles of genomics and Proteomics - Molecular probes - Labelling of probes, Radioactive vs Non radioactive labelling, Uses of molecular probes - Molecular Markers- types and applications, Construction of molecular maps (genetic and physical maps) - DNA chip Technology and Microarrays (a brief account) - Whole genome sequencing and functional genomics (a brief account) -

Module5 : Applications of Molecular Biology and Genetic Engineering (10 Hrs)

Applications of Transgenic Technology : Improving quality, quantity and storage life of fruits and vegetables - Plants with novel features - Engineering metabolic pathways – Pharming - Animal cloning - Ethics of cloning – Applications of Molecular Biology in food industry, forensic sciences, medical science, archaeology and palaeontology.

Reference Books

1. Brown T.A. (2002), Genomes 2nd Edition, John Wiley, New York.
2. Watson J.D. (2000), A Passion for DNA: Genes, Genomes & Society, Cold Spring Harbor Laboratory press (CSHL)
3. Glover D.M. and B.D. Hames (1995), DNA cloning: A Practical Approach, IRL Press, Oxford.
4. Old and Primrose (1995), Principles of Gene Manipulation, Blackwells Publishers,
5. S.M. Kingsman and A.J. Kingsman (1998), Genetic Engineering : An Introduction to Gene Analysis and Exploitation in Eucaryotes, Blackwell Scientific Publications, Oxford,.
6. Sambrook J. E.F. Fritech and T. Maniatis (2000), Molecular cloning: A laboratory Manual, Cold Spring Harbor Laboratory Press, New York
7. Hill W.E. (2000), Genetic Engineering: A Primer, Taylor and Francis.

MG020204–FOOD AND MICROORGANISMS

Teaching Hours/week: 3 **Credits: 3**

Course Outcome:

By attending the course, the students will be able to:

1. Explain the interactions between microorganisms and food and the factors influencing their growth and survival.
2. Understand the significance and activities of microorganisms in foods.
3. Explain the effects of fermentation in food production.

Module 1 : Sensory Characters of Food (10 Hrs)

Definition of food – Sensory or organoleptic factors – appearance factors (size, shape, colour, gloss, consistency, wholeness, patterns) – Textural factors – Texture changes – Flavour factors (smell, taste, mouthfeel, temperature) – Taste interactions

Module2 :Food as a Substrate for Microorganisms (15 Hrs)

Factors affecting microbial growth in food - intrinsic factors – hydrogen ion concentration – moisture or water activity – oxidation- reduction potential – nutrient content – inhibitory substances and biological structure – combined effect of various factors - Extrinsic factors : Temperature of storage – Relative humidity – Concentration of gases

Module 3 : Microorganisms Important in Food Microbiology (15 Hrs)

Molds : General characters, classification and identification – Molds of industrial importance – Yeasts and yeast-like fungi : General characters and classification – Yeasts of industrial importance – Bacteria : Morphological, cultural and physiological characters important in food bacteriology – Genera of bacteria important in food bacteriology

Module4 : General Principles Underlying Spoilage of Food (10 Hrs)

Fitness or unfitness of food for consumption – causes of spoilage – classification of foods by ease of spoilage – factors affecting kinds, numbers and growth of microorganisms in food-chemical changes caused by microorganisms

Module 5 : Production of Cultures for Food Fermentations (10 Hrs)

Selection of cultures – Maintenance of activity and purity of culture – Preparation of culture – Microbial cultures in food fermentation – Bacterial : Lactic acid culture – Propionic culture – Acetic acid bacteria – Yeast : Bakers' yeast – Wine yeasts – Distillers' yeast –Brewers' yeast – Mold cultures

Reference Books

1. Read G. and Nogodwanithana (1991), Yeast Technology, 2nd Edition, AVI Book, Van Nostrant, Reinhold, New York.
2. Lee B.H. (1996), Fundamental of Food Biotechnology, VCH Publishers.
3. Goldberg I. and Williams R. (1991), Biotechnology and Food Ingredients, Van Nostrant., Reinhold, New York.
4. Hui Y.H. (1995), Food Biotechnology: Micro-organism, VCH Publisher.
5. Doyle M.P. (1997), Food Microbiology:Fundamentals and Frontiers, ASM Press Washington.
6. Joshi V.K. and Pandey A. (1999), Biotechnology: Food Fermentation Vol. 1 & 2, Education Publisher and Distributer, New Delhi.
7. Marwaha S.S. and Arora, J.K. (2000), Food Processing: Biotechnological applications, Asia tech Publishers Inc., New Delhi.
8. Frazier W. C. and Westhoff D.C. (1995). Food Microbiology. Fourth Edition. Tata McGraw Hill Publishing Company Limited, New Delhi
9. Adams M.R. and M.O. MOSS (2005*). Food Microbiology*.1st edition. Reprinted, Published by New Age International (P) Limited. Publishers - New Delhi.
10. Vijaya Ramesh, K.(2007). Food Microbiology,MJP Publishers, Chennai.
11. Swaminathan, N. (1987). Food Science and experimental foods. Ganesh Publications, Madras.
12. James M Jay.2004. Modern Food Microbiology.4th Edition, CBS Publishers and Distributors, New Delhi.
13. Joy. J.M. (1970). Modern Food Microbiology, New York: Van Nostrand Reinhold Co.
14. Norman N. Potter (1987). *Food Science* (3rded), New Delhi: CBS Publ. and Distributors.

MG020205- LABORATORY COURSE II

Lab Hours/week: 10 **Credits: 4**

Course Outcome:

By attending the practical, the students will be able to:

1. Learn the basic principles and working of analytical instruments
2. Understand the separation of macromolecules by chromatographic methods
3. Isolate and purify proteins and nucleic acids
4. Study the steps involved in rDNA technology

Experimental Design

1. Studies on pH titration curves of amino acids/ acetic acid and determination of pKa values and Handerson-Hasselbach equation.
2. Separation of bacterial lipids/amino acids/sugars/organic acids by TLC or Paper Chromatography.
3. Separation of serum protein by horizontal submerged gel electrophoresis.
4. Study of UV absorption spectra of macromolecules (protein, nucleic acid, bacterial pigments).
5. Quantitative estimation of hydrocarbons/pesticides/organic Solvents /methane by Gas chromatography.
6. Demonstration of PCR, DNA sequencer and Fermenter.
7. Separation of haemoglobin or blue dextran by gel filtration.
8. Separation of proteins by SDS-PAGE
9. Microscopy : principle and working of SEM/TEM/ Phase contrast/ Fluorescent/confocal microscope
10. Isolation of genomic DNA from bacteria/fungi/plants
11. Isolation of plasmid DNA
12. Determination of purity of the isolated DNA by UV spectrophotometer.
13. Quantification of DNA
14. Restriction digestion of plasmid or genomic DNA
15. DNA cloning using plasmid vectors / expression vectors.
16. Bacterial transformation

17. RFLP analysis.
18. Isolation of RNA
19. Demonstration of Amplification of DNA by PCR
20. Demonstration of southern blotting
21. Visit to a well equipped Biotechnology laboratory

Reference Books

1. Instrumental Methods of Analysis. 6th Edition by H.H. Willard, L.L. Merritt Jr. And others. 1986. CBS Publishers and Distributors.
2. Instrumental Methods of Chemical Analysis. 1989 by Chatwal G and Anand, S. Himalaya Publishing House, Mumbai.
3. A Biologists Guide to Principles and Techniques of Practical Biochemistry. 1975 by Williams, B.L. and Wilson, K.
4. Spectroscopy. Volume 1. Edited by B.B. Straughan and S. Walker. Chapman and Hall Ltd.
5. Gel Electrophoresis of Proteins- A Practical Approach by Hanes.
6. Chromatography: Concepts and Contrasts- 1988 by James Miller. John Wiley and Sons. Inc., New York.
7. Analytical Biochemistry by Holme.
8. Introduction to High Performance Liquid Chromatography by R. J. Hamilton and P. A.Sewell.
1. Practical aspects of Gas Chromatography and Mass Spectrometry 1984 by Gordon M. Message, John Wiley and Sons, New York.
2. Isotopes and radiations in Biology by C.C. Thornburn, Butterworth and Co. Ltd., London.
3. Brown T.A. (2002), Genomes 2nd Edition, John Wiley, New York.
4. Glover D.M. and B.D. Hames (1995), DNA cloning: A Practical Approach, IRL Press, Oxford.
5. Old and Primrose (1995), Principles of Gene Manipulation, Blackwells Publishers,
6. S.M. Kingsman and A.J. Kingsman (1998), Genetic Engineering : An Introduction to Gene Analysis and Exploitation in Eucaryotes, Blackwell Scientific Publications, Oxford.
7. Sambrook J. E.F. Fritech and T. Maniatis (2000), Molecular cloning: A laboratory Manual, Cold Spring Harbor Laboratory Press, New York
8. Hill W.E. (2000), Genetic Engineering: A Primer, Taylor and Francis.

SYLLABUS

Third Semester

M. Sc. Food and Industrial Microbiology

MG020301	Microbial Processes and Products	Core Course
MG020302	Microbial Spoilage and Preservation of Foods	Core Course
MG830301	Food Packaging Technology	Elective 1
MG840301	Basics of Environmental Science	
MG850301	Medical Microbiology	
MG830302	Nutraceuticals	Elective 2
MG840302	Enzyme Technology and Biosensors	
MG850302	Fundamentals of Immunology	
MG020303	Laboratory Course III	Core Course

MG020301 – MICROBIAL PROCESSES AND PRODUCTS

Teaching Hours/week: 4 **Credits: 4**

Course Outcome:

By attending the course, the students will be able to:

1. Understand the production of enzymes, recombinant proteins and vaccines.
2. Study the industrially useful microbial enzymes, their applications in food and pharmaceutical industry.
3. Learn about the production of primary and secondary metabolites.
4. Understand the steps involved in the production of wine, cake, cookies

Module1 :Production of Primary and Secondary Metabolites (20 Hrs)

A brief outline of processes for the production of some commercially important Organic acids (e.g. citric acid, lactic acid, acetic acid, gluconic acid) - Amino acids (Glutamic acid, lysine, aspartic acid, phenylalanine) - Alcohols (ethanol, acetone, butanol)

Study of production processes for various classes of low molecular weight secondary metabolites: Antibiotics-beta-lactams (Penicillin), semi synthetic Penicillins and Cephalosporins- amino-glycosides (streptomycin) - macrolides (erythromycin) - quinines and aromatics - Vitamin (B12, Riboflavin) - Steroids - Dual or multiple fermentation.

Module2 :Production of Enzymes, Recombinant Proteins and Vaccines (20 Hrs)

Industrially useful microbial enzymes (Proteases, Amylases, Lipases, Cellulases, Pectinases, Isomerases, Invertase) and other commercially important enzymes for the food and pharmaceutical industries - Production of recombinant proteins (Insulin, Interleukin & Interferons) having therapeutic and diagnostic applications – production of vaccines - Production of bacterial vaccines - Preparation oftoxoid from a toxin

Module3 : Production of Insecticides, Pesticides, Plastics and Biopolymers (10 Hrs)

Microbial insecticides and pesticides -bioinsecticides (thuricide) - Production of bioplastics (PHB) - biopolymers (dextran, alginate, xanthan, pullulan)

Module4 : Miscellaneous Products and Other Processes (15 Hrs)

Mushroom cultivation - Single Cell Protein - Baker's yeast production –GMOs - Natural Biopreservatives (Bacteriocin/Nisin) - biotransformation of steroid hormones -Biofuels -

biodiesel fromhydrocarbons - biogas production (biomethanation) - Biofertilizers(nitrogen fixer Azotobacter, Phosphate solubilizing microorganisms)- Microbial enhanced recovery of minerals - Microbial production of hydrogen gas - Production of bioethanol from sugar, molasses, starch or cellulosic materials - Bioconversion of vegetable oils - Bioleaching of metals.

Module 5. Fermented Food Products (15 Hrs)

Bread – Malt beverages, Wine, Distilled spirits – Vinegar – Fermented vegetables (sauerkraut, pickles, olives) - Fermented dairy products (Sour cream, Buttermilk, Yogurt, Cheese) –Sausages (pepperomi, salami, bologna, summer sausage) - Oriental fermented food (Tempeh, Miso, Soy sauce, Ang-Khak, Natto, Minchin, Idli, Pidan, Poi) – Vanilla - Tea – Coffee – Cocoa beans

Reference Books

1. Stansbury P.F. *et al.* (1997), Principles of Fermentation Technology, Pergmon Press Oxford.
2. Ward O.P., (1998), Fermentation Biotechnology – Principles, Process and Products. Prentice Hall Publishing, New Jersey.
3. Rehm H.J. Reed G.B. Punler A and Stadler (1993), Biotechnology, Vol. 1-8, VCH Publication.
4. Prescolt and Dunn (1992), Industrial Microbiology, 4th Edition CBS Publication, New York.
5. Arnold I. Demain and Julian E. Davies (1999), Manual of Industrial Microbiology and Biotechnology, 2nd Edition, ASM Press, Washington D.C.
6. Glazer and Nikaido (1998) Microbial Biotechnology By WH Freeman & Company, New York.
7. Cruger and Cruger (2002), Biotechnology –A Textbook of Industrial Microbiology, 2nd Edition ,PanimaPublishering Corporation, New Delhi.
8. Wankat, Phillip C.; Rate-controlled separations . ISBN: 0-7514-0284-2
9. Rautenbach, R.; Membrane processes . ISBN: 0-471-91110-0
10. Ruthven, Douglas M.; Principles of adsorption and adsorption processes . ISBN: 0-471-86606-7
11. Rodrigues, LeVan e Tondeur; Adsorption Science and Tecnology , Kluwer , 1988
12. Percolation Processes: theory and applications , Rodrigues e Tondeur , 1981
13. Rodrigues ; Ion exchange Science and Technology , Kluwer , 1985
14. Biotechnological Innovations in Chemical Synthesis. BIOTOL. Publishers / Butterworth

Heinemann.
15. Industrial Microbiology by G. Reed (Ed), CBS Publishers (AVI Publishing Co.)
16. Biology of Industrial Microorganisms by A.L. Demain.
17. Genetics and Biotechnology of Industrial Microorgansims by C.l. Hershnergey, S.W.
18. Queener and Q. Hegeman. Publisher. ASM. Ewesis ET. Al. 1998. Bioremediation Principles. Mac Graw Hill.
19. Annual Reports in Fermentation Processes by D. Pearlman, Academic Press.
20. Fundamentals of Biochemical Engineering by Bailey and Ollis.
21. Biotechnology, A textbook of industrial Microbiology by Creuger and Creuger, Sinaeur associates.
22. Manual of industrial Microbiology and Biotechnology 2nd edition by Davis J.E. and Demain A.L. ASM publications.

MG020302–MICROBIAL SPOILAGE AND PRESERVATION OF FOODS

Teaching Hours/week: 3 **Credits: 3**

Course Outcome:

By attending the course, the students will be able to:

1. Understand the different food preservation methods.
2. Learn about the contamination, preservation and spoilage of perishable foods.
3. Demonstrate canning procedure.
4. Understand the different sources of contamination of food from natural sources.

Module 1: Contamination of Food from Natural Sources (10 Hrs)

Pre-harvest and post harvest contamination of vegetables and fruits from animals, from sewage, soil, water, and air - Contamination during processing and transport

Module2: Food Preservation Methods (20 Hrs)

Principles and methods - asepsis - Removal - anaerobic conditions, use of high temperature – use of low temperature – drying – radiation - food preservatives: ideal antimicrobial preservatives - added inorganic, organic and developed preservatives

Module 3:Contamination, Preservation and Spoilage of Perishable Foods (20 Hrs)

Vegetables and fruits - Meat and meat products - milk and milk products - fish and other sea foods - Egg and Poultry products.

Module 4:Contamination and Spoilage of Canned foods (15 Hrs)

Canning and appertization – Canning procedures and processes - Cause of spoilage – grouping of canned foods based on pH - types of spoilage of canned foods by bacteria, yeast and fungi – Spoilage of canned meat and fish – Unusual types of spoilage of canned foods

Module 5: Contamination, Preservation and Spoilage of Cereals, Sugars and Miscellaneous Foods (15 Hrs)

Cereals and cereal products - Sugar and sugar products - Contamination of fatty foods, salad dressings, essential oils, bottled beverages, spices and condiments.

Reference Books

1. Read G. and Nogodwanithana (1991), Yeast Technology, 2nd Edition, AVI Book, Van Nostrant, Reinhold, New York.
2. Lee B.H. (1996), Fundamental of Food Biotechnology, VCH Publishers.
3. Goldberg I. and Williams R. (1991), Biotechnology and Food Ingredients, Van Nostrant., Reinhold, New York.
4. Hui Y.H. (1995), Food Biotechnology: Micro-organism, VCH Publisher.
5. Doyle M.P. (1997), Food Microbiology:Fundamentals and Frontiers, ASM Press Washington.
6. Joshi V.K. and Pandey A. (1999), Biotechnology: Food Fermentation Vol. 1 & 2, Education Publisher and Distributer, New Delhi.
7. Marwaha S.S. and Arora, J.K. (2000), Food Processing: Biotechnological applications, Asia tech Publishers Inc., New Delhi.
8. Frazier W. C. and Westhoff D.C. (1995). Food Microbiology. Fourth Edition. Tata McGraw Hill Publishing Company Limited, New Delhi
9. Adams M.R. and M.O. MOSS (2005). Food Microbiology. 1st edition. Reprinted, Published by New Age International (P) Limited. Publishers - New Delhi
10. Vijaya Ramesh, K.(2007). Food Microbiology. MJP Publishers, Chennai.
11. Swaminathan, N. (1987). Food Science and experimental foods. Ganesh Publications, Madras.
12. James M Jay.2004. Modern Food Microbiology.4th Edition, CBS Publishers and Distributors, New Delhi
13. Joy. J.M. (1970). Modern Food Microbiology, New York: Van Nostrand Reinhold Co.
14. Norman N. Potter (1987). Food Science (3rded), New Delhi: CBS Publ. and Distributors.

MG830301 – FOOD PACKAGING TECHNOLOGY

Teaching Hours/week: 4 **Credits: 4**

Course Outcome:

By attending the course, the students will be able to:

1. Understand the fundamentals of packaging technology.
2. Understand the safety evaluation of materials used for packing.
3. Apply and examine the knowledge of properties for selection of packaging materials for foods & food product.
4. Select between different techniques of food packaging.

Module 1 : Fundamentals of Food Packaging (10 Hrs)

Introduction of Food packaging - Need of food packaging - Role of packaging in extending shelf life of foods - Designing of package materials - Testing of package materials - Testing of package performance - Principles in the development of safe and protective packing - Safety assessment of food packaging materials

Module 2 : Food Packaging Systems (15 Hrs)

Food packaging systems, product characteristics and package requirements - Introduction of food packaging system - Different forms of packaging - Rigid, semi-rigid, flexible forms of packaging - Different packaging system for-Dehydrated foods, Frozen foods, Dairy products, Fresh fruits, Vegetables, Meat, Poultry, Sea foods

Module 3 : Food Packaging Materials (20 Hrs)

Introduction of packaging materials - Types of packaging materials their characteristics and uses - Use of paper as a packaging material-Pulping - Fibrillation, Beating, Types of papers ,Testing methods - Use of glass as a packaging material-Composition, Properties, Types,Methods of bottle making - Use of metals as a packaging material - Tinplate containers, Tinning process, Components of tinplate, Tin free steel (TFS), Types of cans, Aluminium containers, Lacquers - Use of plastics as a packaging material-Types of plastics, Plastic films, laminated plastic materials, Co-extrusion

Module 4 Advances in Packaging Technology (15 Hrs)

Package accessories and advances in Packaging technology-Introduction - Active packaging - Modified atmosphere packaging–Controlled atmosphere packaging - Aseptic packaging - Packages for microwave ovens - Biodegradable plastics - Edible gums – Coatings

Module 5 : Food Packaging Equipments (20 Hrs)

Packaging equipment and machinery- Vacuum packaging machine - CA & MA packaging machine - Gas packaging machine - Seal and shrink packaging machine - Form & fill sealing machine - Aseptic packaging systems - Retort pouches - Bottling machines - Carton making machines - Package printing machines

Reference Books

1. Srilakshmi,B.,2005, Food Science., New Age International (P) Limited., New Delhi.
2. Subalakshmi, G and Udipi, S.A, 2001, Food processing and preservation. New Age International Publishers, New Delhi.
3. Potter, N. N, Hotchkiss, J. H, 2000 Food Science. CBS Publishers, New Delhi.
4. Manay, N.S, Shadaksharaswamy, M.,2004, Foods- Facts and Principles, New Age International Publishers, New Delhi
5. Miquel Angelo P R C, Ricardo Nuno C P, Oscar Leandro D S R, Jose Antonio C T, Antonio Augusto V , 2016, Edible Food Packaging: Materials and Processing Technologies, CRC Press. Taylor &Francis ,Boca Raton , FL
6. Luciano P, Sara L,2016, Food Packaging Materials, Springer chamHeildelberg, New York
7. Robertson, G.L. 2006 Food Packaging: Principles and Practice (2nd ed.), Taylor & Francis
8. NIIR. (2003). Food Packaging Technology Handbook, National Institute of Industrial Research Board, Asia Pacific Business Press Inc.
9. Ahvenainen, R. (Ed.) 2003 Novel Food Packaging Techniques, CRC Press,
10. Han, J.H. (Ed.) 2005 Innovations in Food Packaging, Elsevier Academic Press,
11. Coles, R., McDowell, D. and Kirwan, M.J. (Eds.) 2003 Food Packaging Technology, CRC Press

MG840301 – BASICS OF ENVIRONMENTAL SCIENCE

Teaching Hours/week: 4 **Credits: 4**

Course Outcome:

By attending the course, the students will be able to:

1. Study the impact of microorganism on global ecology.
2. Understand the human ecology and evolution.
3. Study about biodiversity and its management.
4. Gain awareness about environmental pollution and control measures

Module1 : Principles and Scope of Environmental Science (20 Hrs)

Earth, Man and environment – ecosystem - pathways in ecosystem - Physical, chemical and biological factors in the environment - Geographical classification and Zones - Structure and functions of ecosystem- Abiotic and biotic components - Energy flows - Food chain - Food web - Ecological pyramids – Study of terrestrial (forest, grass land) and aquatic (fresh water, marine, eustarine) ecosystems - Mineral cycling - Habitat and niche - Major terrestrial biomes - Impact of microorganisms on global ecology - Microorganisms in extreme environment.

Module2 : Ecology and Evolution (15 Hrs)

Human ecology and Human settlement – Community ecology: structure and attributes - Levels of species diversity and its management - Population ecology: characteristics and regulation - Edges and Ecotones - Ecological succession - Common flora and fauna in India - evolution - origin of life and speciation – Lamarckism – Darwinism

Module3 : Biodiversity and its Management (10 Hrs)

Natural resources - Biodiversity status: monitoring and documentation - Biodiversity management approaches - Methods and strategies for conservation of biological diversity - Endangered and Threatened Species - conservation and sustainable development - Hotspots of biodiversity - National parks and Sanctuaries.

Module 4 : Environmental Pollution (20 Hrs)

Air pollution - Primary and Secondary pollutants - Methods of monitoring and control of air pollution - Air Quality standards. Water pollution : Types, Sources and consequences of water pollution, Physio-chemical and Bacteriological sampling and analysis of water quality, Soil pollution : Physio-chemical and Bacteriological sampling as analysis of soil quality -

Soil pollution (pesticides, fertilizers and chemicals, waste effluents, and heavy metals) - Sound pollution : Sources of sound pollution - Noise control and abatement measures - Impact of noise on human health - Radioactive and thermal Pollution - biological indicators of pollution

Module5 : Environmental Impact Analysis(15 Hrs)

Introduction to environmental impact analysis - Impact Assessment Methodologies - Generalized approach to impact analysis - Environmental audit - environmental planning - Environmental priorities in India and Sustainable development - Environment protection- Global environmental problems - Ozone depletion - global warming - climatic change – desertification - green movement - ecofeminism.

Reference Books

1. Chapman JL & Reiss MJ (1999) *Ecology : principles and applications* (Cambridge University Press, Cambridge) 2nd ed.
2. Jones A (1997) *Environmental biology* (Routledge, London)
3. Odum EP & Barrett GW (2005) *Fundamentals of ecology* (Thomson Brooks/Cole, Belmont, CA) 5th Ed
4. Odum EP (1983) *Basic ecology* (Saunders College, Philadelphia, [Pa.] ; London
5. Kumar A (2004) *A Textbook of Environmental Science* (APH Publishing Corporation)
6. Allaby M (2000) *Basics of Environmental Science* (Routledge)
7. Cunningham WP, Cunningham MA, & Saigo BW (2003) *Environmental science : a global concern* (McGraw-Hill, Boston ; London) 7th ed
8. Pickering KT & Owen LA (1997) *An introduction to global environmental issues* (Routledge, London) 2nd ed.

MG850301 – MEDICAL MICROBIOLOGY

Teaching Hours/week: 4 **Credits: 4**

Course Outcome:

By attending the course, the students will be able to:

1. Understand the biological properties and diseases caused by bacteria, virus,fungi and protozoa.
2. Describe the epidemiology of infectious agents including how infectious diseases are transmitted.
3. Evaluate methods used to identify infectious agents in the clinical microbiology lab.
4. Explain general and specific mechanisms by which an infectious agent causes disease.

Module1 : Biological properties and diseases caused by pathogenic bacteria (a brief account) (20 Hrs)

Corynebacterium, Staphylococcus, Streptococcus, Neisseria, Escherichia, Klebsiella, Proteus, Salmonella, Shigella, Vibrio, Campylobacter, Pseudomonas, Acinetobacter, Yersinia, Francisella, Pasteurella, Haemophilus, Bordetella, Bacillus, Clostridium, Mycobacterium, Actinomyces, Nocardia, Bacteroides, Fusobacterium, Listeria, Legionella, Mycoplasma, Rickettsiae, Chlamydiae, Spirochetes

Module2 : Biological properties and diseases caused by Viruses (a brief account)(20 Hrs)

Pox, Herpes, Adeno, Entero, Myxo, Arbo, Rhabdo, Hepatitis, Oncogenic and HIV, Miscellaneous viruses.

Module3 : Biological properties and diseases caused by Fungi (a brief account) (15 Hrs)

Trichophyton, Microsporum, Sporotrichosis, Candidiasis and Aspergillosis.

Module4 : Biological properties and diseases caused by Protozoans (15 Hrs)

Entamoebahistolytica, *Giardia lamblia*, *Trichomonas*, Trypanosomes, *Leishmania*, *Cryptosporidium*, *Plasmodium*, *Toxoplasma* and *Pneumocystis*

Module5 :Diagnostic Procedures (10Hrs)

Collection of Specimens –Transport – Reception – Examination – Reports of results

Reference Books

1. Principles of Microbiology (1994); Atlas,R.M.

2. Pharmaceuticals Microbiology (2003); Purohit&Saluja.

3.Microbiology: A Lab Manual, Cappuccino *et al*.

4.Brock Biology of Microbiology, Martinko,M.T& Parker

5. Gary Walsh. (1998) Biopharmaceuticals: Biochemistry and Biotechnology, John Wiley & Sons, New York.

MG830302– NUTRACEUTICALS

Teaching Hours/week: 4 **Credits: 4**

Course Outcome:

By attending the course, the students will be able to:

1. Understand about probiotic microorganisms, prebiotic foods.
2. Explain the potential health benefits of food components.
3. Study about novel foods, value added foods, Genetically Modified Foods.
4. Understand the risks and side effects of probiotics.

Module1 : Classification (15 Hrs)

Definition, history, classification - Prebiotics, Probiotics and Synbiotics - Nutrient Vs Non-Nutrient, according to target organ, according to source of origin – Functional foods – Organic foods – Value added foods – Enhanced foods – Genetically Modified Foods

Module2 :Probiotics and Probiotic Foods (15 Hrs)

Taxonomy and important features of probiotic microorganisms - Health effects of probiotics including mechanism of action - Probiotics in various foods: fermented milk products, non-milk products etc - Quality assurance of probiotics and safety – Side effects and risks

Module3 : Prebiotics and Prebiotic Foods (15 Hrs)

Definition, Chemistry, Sources, metabolism and bioavailability, effect of processing - Physiological effects, effects on human health and potential applications in risk reduction of diseases - Perspective for food applications for the following - Non-digestible CHO / Oligosaccharides - Dietary fibre, resistant starch, gums.

Module4 : Food Components (others) with Potential Health Benefits (10 Hrs)

Polyphenols: Flavonoids - Catechins–flavones - tannins - Phytoesterogens- PhytosterolsGlucosinolates- Pigments: Lycopene, Curcumin etc - Organo Sulphur Compounds - Other Components - Phytates, Protease inhibitions, saponins, amylase inhibitions, haemagglutinins

Module5 : Non-nutrient Effect of Specific Nutrients (5 Hrs)

Proteins, peptides and nucleotides - conjugated linoleic acid and omega-3 fatty acids - vitamins and minerals.

Reference books

1. Cho S.S. and Dreher, M.L (2001) Hand book Dietary Fibre, Marul Dekker Inc., Ney York

2. Wildman R.E.C. ed (2000) Hand book of Nutraceuticals and functional Foods, CRC. Press Boca Raton.

3. Fuller R. ed (1992) Probiotics the Scientific basis London, Chapman and Hall, New York.

4. Gihsm G, Williams, C-ed (2000) Functional foods, Woodhead Publishing Ltd. U.K.

5. Frei, B, (1994) Natural anti oxidants in human health and disease. Academic Press, San Diego

6. Tannock G.W (1999): Probiotics: A Critical review, Horizon Scientific Press. U.K.

7. Wildman, Robert. Nutraceuticals and Functional Foods, second edition. Taylor and Francis Group. 2007.

8. Gibson GR & William CM. Functional Foods - Concept to Product. 2000.

9. Goldberg I. Functional Foods: Designer Foods, Pharma Foods. 1994.

10. Brigelius-Flohé, J &Joost HG. Nutritional Genomics: Impact on Health and Disease. Wiley VCH. 2006.

11. Cupp J & Tracy TS. Dietary Supplements: Toxicology and Clinical Pharmacology. Humana Press. 2003.

MG840302 – ENZYME TECHNOLOGY AND BIOSENSORS

Teaching Hours/week: 4 **Credits: 4**

Course Outcome:

By attending the course, the students will be able to:

1. Understand the basics of Enzymology.
2. Explain the concept and applications of enzymes in biotechnology-related industries
3. Understand the kinetics of enzymes.
4. Propose a new application for the use of enzymes in biosensor approach to benefit human life

Module1 :Introduction to Enzymology (10 Hrs)

Enzyme : Definition – Classification : Classification of enzymes into six major groups with suitable examples - Numerical classification of enzymes - Active site - Enzymes as biocatalysts, catalytic power, activation energy, substrate specificity, active site, theories of mechanisms of enzyme action

Module2 : Enzyme Types, Biomolecules as Enzymes (10 Hrs)

Monomeric, Oligomeric and multienzyme complex, isozymes and allosteric enzymes - Synthetic enzymes, Ribozymes and abzymes- Vitamins as Coenzymes :Role of vitamins as coenzymes for enzyme catalyzed reactions in different metabolic pathways

Module3 : Enzyme Kinetics (15 Hrs)

Enzyme kinetics: Importance of enzyme kinetics, factors affecting rates of enzyme mediated reactions (pH, temperature, substrate concentration, enzyme concentration and reaction time) Derivation ofMichaelis - Menton equation and its significance in enzyme kinetic studies - Lineweaver-Burk plot - Sigmoidal kinetics - steady state kinetics and transient phases of enzyme reaction - Multistep reactions and rate limiting steps - enzyme inhibition, kinetic analysis of allosteric enzymes - principles of allosteric regulation.

Module4 : Immobilization Technique (10 Hrs)

Physical and Chemical techniques for enzyme Immobilization – adsorption - Matrix entrapment, encapsulation. cross-linking. covalent binding - examples; Advantages - Mass

transfer Effects in Immobilized Enzyme Systems - industrial techniques for whole immobilization - Application and advantages of cell and enzyme immobilization in pharmaceutical, food and fine chemical industries.

Module5 :Biosensors and Probes (15 Hrs)

Definitions and History - Sensors based on: enzymes, affinity and whole cells - Transducers: electrodes, photometric and acoustics - Immobilizations techniques: thin films, micro and nano-structures - Invasive, non- invasive, and disjointed sensors - Continuous vs. discontinuous monitoring – Pitfalls - Signal processing – immunosensors - Novel transducers and synthetic receptors - Clinical, environmental, industrial and military applications - biochips, biofilms and biosurfactants, deterioration of' materials : paper, textiles, painted surfaces, prevention of microbial deterioration - Analytical Microbiology - microbiological assays of Vitamins (riboflavin, B12), amino acids (lysine, tryptophan) and antibiotics (penicillin and streptomycin).

Reference Books

1. Palmer T. (2001) Enzymes Biochemistry, Biotechnology and Clinical Chemistry, 5th Edition, Howood Publishing Chishester, England.
2. Marangoni A.G. (2003), Enzyme Kinetics-A Modern Approach,
3. Price N.C. and Stevens L. (1999), Fundamentals of Enzymology 3rd Edition Oxford University Press, New York.
4. Dixon M. and Webb E.C. (1979), Enzyme, 3rd Edition, Academic Press, New York.
5. Uhlig H (1998), Industrial Enzymes and Their Applicatiopns, Jone Wiley, New York.
6. Allosteric Enzymes - Kinetic Behaviour. 1982. by B.I. Kurganov. John Wiley and Sons. Inc., New York.
7. Biotechnology. Volume 7 A - Enzymes in Biotechnology. 1983 Edited by H. J. Rehm and G. Reed. VerlagChemie.
8. Hand Book of Enzyme Biotechnology by Wiseman.
9. Enzymes as Drugs Edited by John S.Holcenberg and Joseph Roberts, John Wiley & Sons New York.
10. Methods of Enzymatic Analysis by Hans Ulrich, Bergmeyer, Academic Press.
11. Methods in Enzymology by W.A. Wood, Academic Press.
12. Advances in Enzymology by Alton Meister, Interscience Publishers.
13. Topics in Enzyme and Fermentation Biotechnology by L.N. Wiseman, John Wiley and Sons.

MG850302 – FUNDAMENTALS OF IMMUNOLOGY

Teaching Hours/week: 4 **Credits: 4**

Course Outcome:

By attending the course, the students will be able to:

1. Understand the immune response and mechanisms.
2. Study about immunological disorders.
3. Understand the concepts related to cells and organs related to immune system.
4. Describe the basis structure of the cellular receptors and discuss their interactions during an immune response.
5. Understand the principles governing vaccination and the mechanisms of protection against disease.

Module 1: Immune System (12 Hrs)

History of immunology, immunity - innate immunity, acquired immunity; immunohaematology – blood groups, blood transfusion and Rh-incompatibilities - cells and tissues involved in immune system; virulence and host resistance -Complement components, classical and pathways and complement deficiencies - MHC

Module 2: Antigens and Antibodies (10 Hrs)

Infection – types of infectious diseases - Antigens : structure and properties, types, iso- and alloantigens, haptens; adjuvants, antigen processing and specificity; lymphokines; immunoglobulins structure, heterogeneity, types and sub-types, properties (physico-chemical and biological); theories of antibody formation; monoclonal antibodies and their applications.

Module 3: Immune Responses and Antigen-Antibody Reactions (13 Hrs)

Immune responses : Cell mediated immune response - Antibody mediated immune response – production of monoclonal antibodies – immunological tolerance – theories of immune response

In-vitro methods: agglutination, precipitation, complement fixation, immunefluorescence, ELISA, radio-immuno assay, immuno-histochemical staining; *in vivo* methods: skin tests and immune complex demonstration; applications of these methods in diagnosis of microbial diseases – MHC, MHC restriction, HLA

Module 4 :Immunology of Transplantation and Malignancy (10 Hrs)

Immunology of organ and tissue transplantation- Allograft reaction and GVH reaction, Factors influencing allograft survival, Immunology of malignancy- Tumor antigens, Immune response in malignancy, Immunotherapy of cancer, Immunohaematology- ABO and Rh blood group system, Immunology of blood transfusion, Haemolytic disease of new born.

Module 5: Immune System Disorders and Deficiencies (15 Hrs)

Immediate and delayed; Clinical types of hypersensitivity : antibody mediated Type-I anaphylaxis, Type-II Antibody dependent cell cytotoxicity, Type-III immune-complex mediated reactions and Type- IV cell mediated hypersensitivity reactions; respective diseases, immunological methods of their diagnosis. Autoimmunity- Mechanisms of autoimmunity, Autoimmune diseases. Inflammation, Immunodeficiency diseases, Immunoprophylaxis- Vaccines – types of vaccines, DNA vaccine and recent trends in vaccine development - Immunoregulation

Reference Books

1. Immunology - Janis Kuby
2. Essentials of Immunology (6th Edition)- Ivan Roitt
3. Cellular and Molecular Immunology - Abul K. Abbas, Andrew H. Lichtman and Jordan S
4. Immunology: An Introduction - Ian R. Tizard

1. Fundamentals of Immunology – William E. Paul, Raven Press Roitt IM & Delves PJ (2001) *Roitt's essential Immunology*.Blackwell Science, Oxford. 10th ed.
2. Kindt TJ, Goldsby RA, Osborne BA, & Kuby J (2006) *Kuby Immunology*.W.H. Freeman, New York. 6th ed
3. Murphy K, Travers P, Walport M, & Janeway C (2008) *Janeway's Immunobiology*. Garland Science, New York. 7th ed
4. Chapel H (2006) *Essentials of clinical Immunology* .Blackwell, Malden, Mass. ; Oxford. 5th ed
5. Kimball JW (1986) *Introduction to Immunology*.Macmillan, London 2nd ed
6. Paniker CKJ (2006) *Ananthanarayan & Paniker'sTextbook of microbiology*. Orient Longaman. 7th ed.

MG020303 – LABORATORY COURSE III

Lab Hours/week: 10 **Credits: 4**

Course Outcome:

By attending the practical, the students will be able to:

1. Understand the principle and working of equipments used in bioprocesses
2. Learn methods for quantitative estimation of bacteria
3. Learn methods for isolation and identification of pathogenic bacteria
4. Learn methods for selective isolation of some foodborne pathogens
5. Analyze bacteriological quality of water, milk and other food samples

Experimental Design

1. Bioprocess engineering lab visit

2. Demonstration of reactor studies : Batch, fed-batch, and continuous flow reactor analysis and residence time distribution.

3. Determination of Thermal Death Point (TDP) and Thermal Death Time (TDT) of microorganisms for design of a sterilizer.

4. Monitoring of dissolved oxygen during aerobic fermentation.

5. Preservation of industrially important bacteria by lyophilization.

6. Product concentration by vacuum concentrator

7. Cell disruption for endoenzymes by sonication.

8. Mushroom cultivation and its analysis.

9. Production of wine from grapes

10. Baking of cake/bread/cookies

11. Biochemical tests for identification of bacteria : Sugar fermentation, IMViC test, H_2S production, nitrate reduction, starch hydrolysis, oxidase, catalase

12. Enumeration of coliforms; Bacteriological examination of water by multiple tube fermentation test

13. Quantitative estimation of microorganism by TPC : Serial dilution technique; Pour plate Spread plate technique

14. Conventional and rapid methods of isolation and identification of pathogenic bacteria, fungi.

15. Enrichment and Selective isolation of *Salmonella, Shigella, Staphylococcusaureus*, *Vibrio* from spoiled or contaminated foods

16. Bacteriological analysis of milk : by MBRT; mastitis test for milk.

17. Determination of spoilage by Microbiological methods for meat, fish, dairy, fruits, vegetables, cereals, poultry – by SPC, indicator bacteria and pathogens, MBRT

SYLLABUS

Fourth Semester

M. Sc. Food and Industrial Microbiology

MG020401	Food quality and Foodborne Diseases	Core course
MG020402	Biostatistics and Research Methodology	Core course
MG830403	Biosafety, IPR and Patents	Elective -3
MG840403	Microbial Ecology	
MG850403	Dairy Microbiology	
MG020403	Laboratory Course IV	Core course

MG020401 – FOODQUALITY AND FOODBORNE DISEASES

Teaching Hours/week: 4 **Credits: 4**

Course Outcome:

By attending the course, the students will be able to:

1. Demonstrate the different sensory methods used for the quality determination of various foods.
2. Perform various tests to detect the presence of adulterants in foods.
3. Understand the various food laws and standards.
4. Understand the importance of Quality Control and Quality Assurance.

Module1 :Foodborne Diseases, their Surveillance and Detection (20 Hrs)

Bacterial : Food Poisoning by *Staphylococcus, Clostridium perfringens, Clostridium botulinum,, Salmonella, Brucella, E. coli O157:H7, Shigella, Bacillus cereus, Yersinia enterocolitica, Vibrio cholerae, Vibrio parahaemolyticus, Listeria monocytogenes* - Fungi – Mycotoxins – Aflatoxin, Luteoskyrin, ochratoxin, patulin, trichothecenes, Roquefortine. – Protozoas :*Entamoebahistolytica*, *Cryptosporidium*, *Giardia* and *Cyclospora* - Seafood Toxicants: Shellfish poisoning – ciguatera poisoning – scombroid fish poisoning - viral gastroenteritis, infectious hepatitis, poliomyelitis, Viral Diarrhoea – Rotavirus – Norwalk virus

Trends in foodborne disease - Incidence of foodborne disease - Foodborne disease surveillance- Emerging foodborne disease - Control of foodborne diseases

Detection by Conventional microbiological techniques - Molecular diagnosis - Rapid and automated methods : PCR, Real Time -PCR, Quantitative PCR - Use of nucleic acid probes and antibodies in clinical diagnosis.

Module2 : Quality Evaluation of Foods (15 Hrs)

Sensory evaluation - definition and importance of sensory evaluation in relation to consumer acceptability and economic aspects-factors affecting food acceptance-terminology related to sensory evaluation - scoring procedures: types of tests-difference test-paired test duo trio-

triangle-ranking-scoring hedonic scale and descriptive tests-panel selection-screening and training of judges-requirement of sensory evaluation-sampling procedures-factors affecting sensory measurements. Chemical methods used in quality evaluation- Moisture, PR, HM, TVBN, Peroxide value, Acidity/ acid value detection of adulterants, Microbiological evaluation

Module3: Food Laws and Standards (15 Hrs)

Food laws and standards - Food regulations, grades and standards - Food safety objectives - National food legislation/ authorities and their role - product certifications: ISI mark of BIS, AGMARK, FPO, MFPO, international organization and agreements-food and agricultural organization (FAO), Concept of Codex Alimentarius/HACCP /USDA/ISO 9000 series /ISO22000 / Government regulatory practices and policies/FDA perspectives / PFA act and rules – Food Packaging and labelling

Module4 :Food Safety and Sanitation (15 Hrs)

Introduction, principles of sanitation, sanitation chemicals, disinfectants, sanitation methodology, sanitation procedures, CIP and COP- evaluating the effectiveness of sanitation programmes - Good Manufacturing Practices (GMP) and Good Laboratory Practices (GLP) in pharmaceutical industry - Regulatory aspects of quality control - ISO, WHO and US certification

Module 5 : Quality Control and Quality Assurance (15 Hrs)

Importance and functions of quality control - Methods for quality assessment - Sterilization control and sterility testing (heat sterilization, D value, z value, survival curve, Radiation, gaseous and filter sterilization) - Sampling and specification of raw materials and finished products - Statistical quality control – A comparison of Quality Control and Quality Assurance - Use of microbiology methods in a Quality-Control system - Use of microbiology methods in a Quality Assurance system

Reference Books

1. Read G. and Nogodwanithana (1991), Yeast Technology, 2nd Edition, AVI Book, Van Nostrant, Reinhold, New York.
2. Lee B.H. (1996), Fundamental of Food Biotechnology, VCH Publishers.
3. Goldberg I. and Williams R. (1991), Biotechnology and Food Ingredients, Van Nostrant., Reinhold, New York.

4. Hui Y.H. (1995), Food Biotechnology: Micro-organism, VCH Publisher.

5. Doyle M.P. (1997), Food Microbiology:Fundamentals and Frontiers, ASM Press Washington.

6. Joshi V.K. and Pandey A. (1999), Biotechnology: Food Fermentation Vol. 1 & 2, Education Publisher and Distributer, New Delhi.

7. Marwaha S.S. and Arora, J.K. (2000), Food Processing: Biotechnological applications, Asia tech Publishers Inc., New Delhi.

8. Frazier W. C. and Westhoff D.C. (1995). Food Microbiology. Fourth Edition. Tata McGraw Hill Publishing Company Limited, New Delhi

9. Adams M.R. and M.O. MOSS (2005*)*. Food Microbiology. 1st edition. Reprinted, Published by New Age International (P) Limited. Publishers - New Delhi

MG020402 – BIOSTATISTICS AND RESEARCH METHODOLOGY

Teaching Hours/week: 4 **Credits: 4**

Course Outcome:

By attending the course, the students will be able to:

1. Develop skills in different computational methods used in basic Biostatistics.
2. Study about different softwares used in Bioinformatics.
3. Demonstrate the biological databases for protein and nucleic acids.
4. Get familiar with various research institutes, schemes, funding agencies

Module1 : Introduction to Biostatistics (15 Hrs)

Basic definitions and applications. Sampling: Representative sample, sample size, sampling bias and sampling techniques. Data collection and presentation : Types of data, methods of collection of primary and secondary data, methods of data presentation, graphical representation by histogram, polygon, ogive curves and pie diagram, interpretation of data

Module2 : Measures of Central Tendency (15 Hrs)

Measures of central tendency: Mean, Median, Mode - Measures of variability: Standard deviation, standard error, range, mean deviation and coefficient of variation. Correlation and regression: Positive and negative correlation and calculation of Karl- Pearsons co-efficient of correlation. Linear regression and regression equation and multiple linear regression, ANOVA, one and two way classification. Calculation of an unknown variable using regression equation.

Module3 : Tests of Significance (20 Hrs)

Tests of significance : Small sample test (Chi-square t test, F test), large sample test (Z test) Introduction to probability theory and distributions, (concept without deviation) binomial, poison and normal (only definitions and problems) Computer oriented statistical techniques.

Frequency table of single discrete variable, bubble spot, computation of mean, variance and standard Deviations, t test , correlation coefficient

Module4 : Research Methodology (15 Hrs)

Goals of research – Types of research – Data and method of data collection – Steps in doing research – Experimental design – Research institutes – Research schemes (minor and major) –Preparation of research scheme/formats – Funding agencies (DBT,DST,ICAR,ICMR)

Module5 : Scientific Writing and Presentation of Scientific Data (15 Hrs)

Scientific writing: research article, dissertation, review, abstract, synopsis, technical report – Structure and language - Literature search, analysis of scientific report, compilation of data, presentation of experimental data, tabulation, graph, diagrams, histograms, interpretation of tables, graphs, photographs, and diagrams – Peer review – ethics in publication – plagiarism- Presentation tools : oral and poster, Microsoft Power Point and PDF slides

Reference books

1. Gupta SP (2010) *Statistical Methods.*Sultan Chand & Sons. 28th ed.
2. Palanisamy .S and Manoharan M.(1994).Statistical methods for Biologists. Palani paramount
3. Khan I.A, Khanum.A, (2008) Fundamentals of Biostatistics. Ukaas Publications, Hyderabad. 3rd ed.
4. George W. Snedecor, William G. (1989) Cochran *Statistical Methods*. Iowa State University Press. 8th ed.
5. Kothari CR (2008) *Research Methodology: Methods and Techniques*.New Age International Limited. 2nd ed.

MG830403– BIOSAFETY, IPR AND PATENTS

Teaching Hours/week: 4 **Credits: 4**

Course Outcome:

By attending the course, the students will be able to:

1. Familiarize with regulatory practices and policies.
2. Study about international marketing and trade.
3. Comprehend benefits of GM technology and related issues
4. Recognize importance of protection of innovative ideas and its role in business

Module1 :Agricultural Biotechnology and The Society (10 Hrs)

Transgenic plants, Commercial status and public acceptance, Bio-safety guidelines for research involving GMO's, Benefits and risks, Socio-economic impact and ecological considerations of GMO's, Gene flow.

Module2 :Patents (15 Hrs)

Patents, Plant Variety Protection Act, Procedure for patent application, International harmonization of patent laws, Patenting of life forms - plant, animals, microbes, gene, process and products, Plant Breeders Rights - International conventions on biological diversity.

Module3 : Regulatory Practices (10 Hrs)

Financing R&D capital and market outlook. IP, BP, SP. Government regulatory practices and policies, FDA perspective. Reimbursement of drugs and biologicals, legislative perspective.

Module4 : Intellectual Property Rights and Protection (IPP) (15 Hrs)

GATT and TRIP, Concept of Patents, Copyrights, Trademarks; Patenting – need for patents, Patenting of Biological materials, Regulatory issues and Challenges to food product Patent process, protection of knowledge, knowledge consortia and databases

Module5 : International Marketing and Trade (10 Hrs)

Salient features of international marketing - international trade - Export and import - Exports: direct exports, indirect exports, licensing joint ventures, direct investment and internationalization process Composition of Indian exports - Product promotion, price, distribution channels - Deciding the market organization - Sanitary and Phyto-sanitary measures - Technical barrier to trade and AOA

Reference Books

1. Gupta P.K. (2003), Biotechnology and Genomics, Rastogi Publications Meerut
2. Stewant-tull, D.E.S. &Sussman, M(Eds.) 1994. The release of Genetically Modified Microorganims, REGEM 2, Plenum Press, New York.Bills, D. and Kind, Shain-Daw (ed) 1990, Biotechnology and Food safety Butterworth-Heinemann Boston, London .
3. Gasser, C.C. and Eraley, R.T. 1989. Genetically engineering plants for crops improvements Science 1293-1296.
4. Discon, b. 1992. Morals, ethics, and biotechnologhy Biotechnology.
5. Karmach, C.L. (eds) 1991. Biotechnology Regulations Handbook, Centre for energy and environmental management, Fanifac Stn. Vingnia.
6. Monney, H.A. and Bernandi, G (ed) 1993 Introduction of genetically modified organisms into the environment, Wiley, New York.
7. Sussman, M., Collmi, C.H., Shimnen, A.A. and Stewart-tull D.E. 1994.

MG840403 – MICROBIAL ECOLOGY

Teaching Hours/week: 4 **Credits: 4**

Course Outcome:

By attending the course, the students will be able to:

1. Understand the relation of microbes to environment.
2. Know concepts related with microbial interaction.
3. Understand the use, importance and recycling of liquid and solid waste.
4. Study diversity, composition, and function of microbial communities

Module 1 : Microbiology of Air(10 Hrs)

Aerobiology –Density of microorganisms in air – Outdoorand Indoor Microflora - Sources of contamination - Microbial indicators of air pollution - Enumeration of bacteria in air - Air sampling devices - Air sanitation - aeroallergens and aeroallergy- Effect of Air Pollution on plants and Human -Airborne transmission of diseases

Module2 : Microbiology of Water (10 Hrs)

Aquatic microbiology – Types of water – Marine microbiology – fresh water microbiology - Water pollution and water borne pathogens – Microbiological analysis of water purity – Indicator organisms - purification and disinfection of water - Microbiology of sewage – BOD, COD - sewage (Waste water) treatment

Module3 : Microbiology of Soil (15 Hrs)

Physicochemical properties of soil - Microbial flora of soil – Rhizosphere and Rhizoplane microorganisms - Biogeochemical cycling – Nitrogen, Carbon, Phosphorus, Sulphur cycles and microorganisms associated with it - Biofertilizers for sustainable agriculture *Rhizobium Azospirillium, Azotobacter, Azolla,* Blue Green Algae - mass production methods - application methods of biofertilizers - significance of biofertilizers

Module4 : Ecological Groups and Microbial Interactions (15 Hrs)

Ecological groups of microorganisms (temperature, pH, oxygen requirement, carbon and energy source, habitat, mode of nutrition) - Microbial interaction – Plant-microbe, animal microbe, microbe-microbe interactions – Mycorrhiza – Nematophagous fungi - Nitrogen fixation : Symbiotic and free living nitrogen fixers - Biological Nitrogen fixation - Phosphate solubilizers

Module5 : Microbial Transformation and Degradation of Toxic or Organic Chemicals

(10 Hrs)

Recycling of liquid and solid wastes – Organic compost – Biogas – Biodegradation – Bioremediation - Microbial leaching - Microbial degradation of xenobiotics - Microbial corrosion - Biofilms – Microbial degradation of petroleum products - Microbes in mineral leaching – Heavy metal tolerance in microbes - oil recovery – Microbial plastics

Reference Books

1. Mitchell R (1974) *Introduction to environmental microbiology* (Prentice-Hall, Englewood Cliffs, N.J.,)
2. Atlas RM & Bartha R (1998) *Microbial ecology : fundamentals and applications* (Benjamin/Cummings, Menlo Park, Calif. ; Harlow) 4th ed.
3. Campbell RE (1983) *Microbial ecology* (Blackwell Scientific Publications, Oxford ; Boston) 2nd ed
4. Rheinheimer G (1991) *Aquatic microbiology* (John Wiley and Sons) 4th ed
5. Dart RK (1980) *Microbiological aspects of pollution control* (Elsevier Scientific, Amsterdam) 2nd ed.
6. Alexander M (1977) *Introduction to soil microbiology* (Wiley, New York ; London) 2nd ed.
7. Rao NSS (1995) *Soil microorganisms and plant growth* (Science Publishers, Inc.; New Hampshire, U.S.A) 3rd ed.

MG850403 – DAIRY MICROBIOLOGY

Teaching Hours/week: 4 **Credits: 4**

Course Outcome:

By attending the course, the students will be able to:

1. Understand the pathogenic microorganisms transmitted through raw milk.
2. Know about various preservation techniques in milk.
3. Describe the composition of starter cultures and their use in dairy products
4. Display knowledge on culture dependent and culture independent techniques for quantification of microorganisms from dairy products.

Module 1 : Properties of milk (8 Hrs)

Composition of milk of different animals – classes of milk - Microorganisms of concern in milk - Factors influencing microbial growthin milk - antibacterial properties of milk - Scope of dairy microbiology

Module 2 (10 Hrs)

Preservation techniques in milk and milk based products – Asepsis, removal of microorganisms, anaerobic conditions, high and low temperatures, drying, irradiation, Chemical and bio preservatives and food additives

Module 3 (15 Hrs)

Products from milk : market milk – condensed and dry milk products –frozen desserts

Fermented Dairy Products : Starter cultures : their isolation, production, maintenance, biochemical characters - Products : Cream Cheese, yogurt, butter and Indigenous dairy products of India – probiotic dairy products

Module 4 (12 Hrs)

Human pathogens transmitted through rawmilk and other dairy products:*Bacillus cereus*, *Campylobacter jejuni*, *Escherichia coli*O157: H7, *Listeria monocytogenes*, *Salmonella* spp., *Yersinia enterocolitica*

Diseases transmitted through milk : brucellosis, tuberculosis, Q fever

Module 5 (15 Hrs)

Quality analysis of milk: platform tests in milk - SPC, MBRT, alkaline phosphatase test, Resazurin test, clot on boiling test, titratable acidity, butter fat content test - FSSAI standards of milk - PMO - MMPO

References

1. Frazier W. C. and Westhoff D.C. (1995). Food Microbiology. Fourth Edition. Tata McGraw Hill Publishing Company Limited, New Delhi

2. Adams M.R. and M.O. MOSS (2005). Food Microbiology. 1st edition. Reprinted, Published by New Age International (P) Limited. Publishers - New Delhi

3. Robinson R.K. (2002) Dairy Microbiology: Milk and Milk Products, 3rd Edn. Wiley Publishers.

4. Banwart JM. (1987). *Basic Food Microbiology*. 1st edition. CBS Publishers and Distributors, Delhi, India

5. Patel AH. (1996). *Industrial Microbiology*. 1st edition, Macmillan India Limited.

6. Stanbury PF, Whitaker A and Hall SJ. (2006). *Principles of FermentationTechnology*. 2nd edition, Elsevier Science Ltd

7. Betty C. Hobbs, Food Microbiology, Arnold-Heinemann Publishing Private Ltd

8. Hammer B. W. and Babal, Dairy Bacteriology, Prentice Hall Incorporated

9. Jay J.M., Modern Food Microbiology, CBS Publishers and Distributors, New Delhi. India

10. Pelczar M.J., Chan E.C.S. and Krieg N.R., Microbiology, McGraw Hill Boo

MG020403 – LABORATORY COURSE IV

Lab Hours/week: 13 **Credits: 5**

Course Outcome:

By attending the practical, the students will be able to:

1. Learn methods for organoleptic analysis of foods
2. Learn methods for chemical evaluation of foods
3. Learn methods for microbiological evaluation of foods
4. Understand how to effectively use statistical methods for data analysis
5. Understand and use softwares for DNA and protein sequence analysis

Experimental Design

1. Sensory evaluation of milk/ meat/ fish/cereal products /fruit juice/beverages
2. Developing a score card - nine point hedonic scale
3. Sensory testing methods - Preference / acceptance tests, Discriminatory tests, Descriptive tests: Triangle test, simple paired comparison test, multiple paired comparison test, duo-trio test
4. Chemical evaluation- Moisture, PR, HM, TVBN, Peroxide value, Acidity/ acid value
5. Detection of adulterants
6. Microbiological evaluation : Enumeration of coliforms, MPN, TPC
7. Application of mean, median, mode
8. Computer oriented statistical analysis - t test, Chi-square t test, Standard deviation, ANOVA
9. Online Bibliographic and patent search.
10. Sequence information resource
11. Understanding and using on web: Embl,Genbank, Entrez, Unigene
12. Understanding and using on web: PDB, Swissprot, TrEMBL

13. Using BLAST and interpretation of results
14. Multiple sequence alignment using ClustalW
15. Construction of phylogenetic tree