



MAHATMA GANDHI UNIVERSITY
KOTTAYAM,
KERALA, INDIA

SCHEME AND SYLLABUS

OF

M.Sc. FOOD AND INDUSTRIAL MICROBIOLOGY
PROGRAMME

(UNDER CSS)

(W.E.F. 2013 ADMISSIONS)

SCHEME

Scheme of Examinations Semester-wise
M. Sc. FOOD AND INDUSTRIAL MICROBIOLOGY

A. Scheme of Examination for First Semester M.Sc. Food and Industrial Microbiology

Course No.	Course Code	Subject	Credits	Teaching hrs/week	Total hours
Core 1	FDIM101	General Microbiology	4	4	72
Core 2	FDIM102	Principles of Biochemistry	4	4	72
Core 3	FDIM103	Microbial Physiology, Metabolism and Genetics	4	4	72
Core 4	FDIM104	Food Chemistry	3	3	54
Practical I	FDIM1P1	Laboratory Course I : Based on FDIM101 and FDIM102	4	10	180
		Total	19	25	450

B. Scheme of Examination for Second Semester M.Sc. Food and Industrial Microbiology

Course No.	Paper Code	Subject	Credits	Teaching hrs/week	Total hours
Core 5	FDIM205	Bioanalysis and Instrumentation	4	4	72
Core 6	FDIM206	Food and Microorganisms	3	3	54
Core 7	FDIM207	Molecular Biology and Genetic Engineering	4	4	72
Core 8	FDIM208	Fermentation Technology	4	4	72
Practical II	FDIM2P2	Laboratory Course 2 : Based on FDIM205 and FDIM207	4	10	180
		Total	19	25	450

C. Scheme of Examination for Third Semester M.Sc. Food and Industrial Microbiology

Course No.	Paper Code	Subject	Credits	Teaching hrs/week	Total hours
Core 9	FDIM309	Microbial Processes and Products	4	4	72
Core 10	FDIM310	Microbial Spoilage and Preservation of Foods	4	4	72
Elective 1*	As selected by the student		4	4	72
Elective 2*	As selected by the student		4	4	72
Practical III	FDIM3P3	Laboratory Course 3 : Based on FDIM309 and FDIM310	4	9	162
		Total	20	25	450

***List of Courses for Electives 1 and 2**

1. FDIM3E1 : Enzyme Technology and Biosensors
2. FDIM3E2 : Fundamentals of Immunology
3. FDIM3E3 : Microbial Ecology
4. FDIM3E4: Basics of Environmental Science
5. FDIM3E6 : Essentials in Food Science

D. Scheme of Examination for Fourth Semester M.Sc. Food and Industrial Microbiology

Course No.	Paper Code	Subject	Credits	Teaching hrs/week	Total hours
Core 11	FDIM411	Food Poisoning, Food infection and Foodborne Diseases	4	4	72
Core 12	FDIM412	Biostatistics And Research Methodology	4	4	72
Elective 3*	As selected by the student		3	3	54
Practical IV	FDIM4P4	Laboratory Course 4 : Based on FDIM411 and FDIM412	4	10	180
Project	FDIM4D	Project	4	-	-
Viva Voce	FDIM4V	Course Viva	3	-	-
		Total	22	21	378
		Grand Total (Semester I, II, III, IV)	80		

* List of Courses for Elective 3

1. FDIM4E6 : Biosafety, IPR and Patents
2. FDIM4E7 : Nutraceuticals
3. FDIM4E8 : Medical Microbiology

SYLLABUS

M. Sc. FOOD AND INDUSTRIAL MICROBIOLOGY

First Semester M. Sc. Food and Industrial Microbiology

FDIM101 – Core 1 : GENERAL MICROBIOLOGY

Number of Hours / Week: 4

Credits: 4

Unit 1 : An overview of Microbial World

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

Unit 2 : General Properties of Microorganisms

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 - Virion and Prions - Fungi – Properties and classification – General characters of Yeasts, Algae, Protozoa

Unit 3 : Control of Microorganisms

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.

Unit 4 : Microbial Growth, Culturing and Characterization

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

Unit 5 : Bacterial Identification, Characterization and Taxonomy,

Identification of bacteria - Staining reactions - Cultural, physiological and biochemical properties - Molecular methods for identification - 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). Microbiology 5th 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. Alexopoulos 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.

FDIM102 – Core 2 : PRINCIPLES OF BIOCHEMISTRY

Number of Hours / Week: 4

Credits: 4

Unit 1 : Composition of Living Matter

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

Unit 2 : Structural Features and Chemistry of Macromolecules

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

Unit 3: Overview of Metabolism

Metabolism of biomolecules - carbohydrates, lipids, proteins and nucleic acids - Intermediary metabolism - hormone regulation of metabolism with specific reference to insulin, glucagon, epinephrine, thyroid hormones-Digestion and absorption of carbohydrates, proteins and lipids

Unit 4 : Bioenergetics

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.

Unit 5 : Enzymes as Biocatalysts

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, New York.
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.

FDIM103 – Core 3 : MICROBIAL PHYSIOLOGY, METABOLISM AND GENETICS

Number of Hours / Week: 4

Credits: 4

Unit 1 : Bacterial Physiology

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

Unit 2 : Bacterial Photosynthesis

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.

Unit 3 : Bacterial Permeation

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*, Stationery phase in *E. coli* etc. Transport systems across membrane active and passive transport.

Unit 4 : Bacterial Genetics

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.

Unit 5 : Mutation and Repair

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 Rogery Stanier, Academic Press.
8. Microbial Physiology by Benjamin

FDIM104 – Core 4 : FOOD CHEMISTRY

Number of Hours / Week: 3

Credits: 3

Unit 1 : Introduction to Chemistry of Foods : Carbohydrates, Amino Acids and Proteins

Composition and factors affecting composition of foods - Moisture in foods and determination of moisture

Carbohydrates - Chemistry of cellulose, starches, other polysaccharides - Gel formation and starch degradation - Pectic substances, their occurrence structure, properties and use in foods - Plant acids, acidity, taste

Physical and chemical properties of proteins – Conformation - functional properties of proteins in foods - hydrolysis of proteins - Major food proteins and their sources - Changes in proteins during processing - Determination of Proteins

Unit 2 : Chemistry of Oils and Fats

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

Unit 3 : Structure and Chemistry of Cereals, Pulses and Oil Seeds

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

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

Oilseeds: Structure of prominent oilseeds (Sunflower mustard, cotton seed, ground nut, cashewnut and coconut) – Their chemical compositions and nutritional values - Distribution of vitamins, proteins, minerals, carbohydrates and fats in different oilseeds

Unit 4 : Chemistry of Food Processing

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 Nostrand 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, Sakuntala Manay and shadaksaraswamy, M (1987) Allied Publishers, New Delhi.

FDIM1P1- LABORATORY COURSE 1

(Based on FDIM101- General Microbiology, FDIM102- Principles of Biochemistry and FDIM104 - Food Chemistry)

Credits 4

General Microbiology

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. Testing of disinfectants
11. Antibiotic sensitivity tests- disc diffusion, MIC
12. Determination of microbial number, generation time
13. Factors influencing bacteria : pH, Temperature
14. Anaerobic culture methods
15. Methods of microbial culture preservation.

Principles of Biochemistry

1. Systematic identification of biomolecules – Qualitative tests for amino acids and protein - Biuret test, Millon's test, Nitroprusside test, Ninhydrin test, Sakaguchi test.
2. Qualitative test for carbohydrates- Molisch's test, Bial's test, Benedicts test, Barfoeds test, Fehlings test, Seliwanof's test, Mucic acid test, Iodine test.
3. Qualitative test for Lipids- acrolien test, test for saturation, test for unsaturation, saponification test
4. Qualitative test for NPN substances-Urease test, Phosphotungstic acid test, Jaffes test, Uric acid test.
5. Quantitative tests for carbohydrates proteins and nucleic acids - Detection and estimation of lipids.
6. Preparation of solutions: Percentage solutions, Molar solutions, Normal solutions, Dilution of Stock solutions

SYLLABUS

Second Semester M. Sc. Food and Industrial Microbiology

FDIM205 - Core 5 : BIOANALYSIS AND INSTRUMENTATION

Number of Hours / Week: 4

Credits: 4

Unit 1 : Microscopic Techniques

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

Unit 2 : Basic Laboratory Instruments

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.

Unit 3 : Chromatographic and Electrophoretic Techniques

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-TOFF - 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

Unit 4 : Colorimetry and Spectroscopy

Principles of colorimetry: verification of Beer's law, estimation of a selected protein, finding out I_{max} , 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

Unit 5 : Radioisotopic techniques

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

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). Microbiology 5th edition. Tata McGraw Hill, New Delhi
 4. Powar & duginawala (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.
- 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.

FDIM206 - Core 6 : FOOD AND MICROORGANISMS

Number of Hours / Week: 3

Credits: 3

Unit 1 : Food as a Substrate for Microorganisms

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

Unit 2 : Microorganisms Important in Food Microbiology

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

Unit 3 : General Principles Underlying Spoilage of Food

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

Unit 4 : Contamination of Food from Natural Sources

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

Reference Books

1. Read G. and Nogodwanithana (1991), Yeast Technology, 2nd Edition, AVI Book, Van Nostrand, 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 Nostrand., 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

FDIM207 - CORE 7 : MOLECULAR BIOLOGY AND GENETIC ENGINEERING

Number of Hours / Week: 4

Credits: 4

Unit 1 : Isolation, Sequencing and Synthesis of Genes

Historical background, Structure of DNA, RNA – Types of DNA and RNA – 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.

Unit 2 : Cloning and Expression Vectors

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, λ EMBL, λ WES λ B', 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,

Unit 3 : Recombinant DNA Technology

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 homopolymer tailing - Restriction mapping - Construction of chimaeric DNA - Addition of poly A and poly T tails - Ligation : blunt end and staggered end – Linkers - Adaptors

Unit 4 : Genomics and Proteomics

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) -

Unit 5 : Applications of Molecular Biology and Genetic Engineering

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. Fritsch 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.

FDIM208 - Core 8 : FERMENTATION TECHNOLOGY

Number of Hours / Week: 4

Credits: 4

Unit 1: Fermentation Process

An introduction to fermentation processes - the range of fermentation processes - 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

Unit 2 : Microbial Growth Kinetics

Growth curve of bacteria – Types of culture : batch culture, continuous culture, fed-batch culture, applications and examples - scale up of fermentation processes - Sterilization of media, fermentor and feeds - Inoculum development for large scale bioprocesses - Multistage systems - Feed back systems - Solid substrate fermentation - Instrumentation and control

Unit 3: Fermentation Media

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

Unit 4 : Fermenter Design

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.

Unit 5 : Processes for Recovery of Products

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 Microorganisms by C.I. Hershenberg, S.W. Queener and Q. Hegeman. Publisher. ASM.
5. Eweis *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. Clifton (Volumes)
9. Biotechnology, A textbook of industrial Microbiology by Creuger and Creuger, Sinauer associates.
10. Manual of industrial Microbiology and Biotechnology 2nd edition by Davis J.E. and Demain A.L. ASM publications

FDIM2P2- LABORATORY COURSE II

(Based on FDIM205- Bioanalysis and Instrumentation and FDIM207- Molecular Biology and Genetic Engineering)

Credits 4

Bioanalysis and Instrumentation

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 sequence and Fermenter.
7. Separation of haemoglobin or blue dextran by gel filtration.
8. SDS-PAGE

Molecular Biology and Genetic Engineering

1. Isolation of genomic DNA from bacteria/fungi/plants
2. Isolation of plasmid DNA
3. Determination of purity of the isolated DNA by UV spectrophotometer.
4. Quantification of DNA
5. Restriction digestion of plasmid or genomic DNA
6. DNA cloning using plasmid vectors / expression vectors.
7. Bacterial transformation
8. RFLP analysis.
9. Isolation of RNA
10. Demonstration of Amplification of DNA by PCR
11. Demonstration of southern blotting
12. Visit to a well equipped Biotechnology laboratory

SYLLABUS

Third Semester M. Sc. Food and Industrial Microbiology

FDIM309 - Core 9 : MICROBIAL PROCESSES AND PRODUCTS

Number of Hours / Week: 4

Credits: 4

Unit 1 : Production of Primary and Secondary Metabolites

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 Pencillins and Cephalosporins - amino-glycosides (streptomycin) - macrolides (erythromycin) - quinines and aromatics - Vitamin (B12, Riboflavine) - Steroids - Dual or multiple fermentation.

Unit 2 : Production of Enzymes, Recombinant Proteins and Vaccines

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 of toxoid from a toxin

Unit 3 : Production of Insecticides, Pesticides, Plastics and Biopolymers

Microbial insecticides and pesticides - bioinsecticides (thuricide) - Production of bioplastics (PHB) - biopolymers (dextran, alginate, xanthan, pullulan) - biofertilizers (nitrogen fixer Azotobacter, Phosphate solubilizing microorganisms)

Unit 4 : Miscellaneous Processes and Processes

Genetically Natural Biopreservatives (Bacteriocin/Nisin) - biotransformation of steroid hormones - Biofuels - biodiesel from hydrocarbons - biogas production (biomethanation) - Microbially enhanced recovery of minerals - Microbial production of hydrogen gas - Production of bioethanol from sugar, molasses, starch and cellulosic materials - Bioconversion of Vegetable Oils - Bioleaching of metals- Production of biochemical from microalgae

Unit 5. Fermented Food Products and Microorganisms as Food

Bread – Malt beverages (wine, beer, Sake, Pulque, distilled spirits) – Vinegar – Fermented vegetables (sauerkraut, pickles, olives) - Fermented dairy products (Sour cream, Buttermilk, Yogurt, Cheese) – Sausages (pepperoni, salami, bologna, summer sausage) - Oriental fermented food (Tempeh, Miso, Soy sauce, Ang-Khak, Natto, Minchin, Idli, Pidan, Poi) – Tea – Coffee – Coca beans – Mushroom cultivation - Single Cell Protein - Baker's yeast production – GMOs – Genetically Modified Foods - Probiotics – Prebiotics – Synbiotics

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. Prescott 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 , Panima Publishing 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.I. 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.

FDIM310 - Core 10 : MICROBIAL SPOILAGE AND PRESERVATION OF FOODS

Number of Hours / Week: 4

Credits: 4

Unit 1 : Principles of Food Preservation

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

Unit 2 : Contamination, Preservation and Spoilage of Perishable Foods

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

Unit 3 : Spoilage of Heated Canned foods

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

Unit 4 : Contamination, Preservation and Spoilage of Cereals and Sugars

Cereals : Preservation methods – Spoilage of grains and meals - Flours – Bread – Bakery
Products – Breakfast Cereals and Snacks

Sugar and sugar products – Preservation methods – spoilage of sucrose – maple sap and sirup
– Honey - Candy

Unit 5 : Miscellaneous Foods

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 Nostrand, 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 Nostrand., 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

FDIM3E1 - Elective 1: ENZYME TECHNOLOGY AND BIOSENSORS

Number of Hours / Week: 4

Credits: 4

Unit 1 : Introduction to Enzymology

Enzyme : Definition – Classification : Classification of enzymes into six major groups with suitable examples - Numerical classification of enzymes - Active site - Mechanism of enzyme action - Enzymes as biocatalysts, catalytic power, activation energy, substrate specificity, active site, theories of mechanisms of enzyme action (Induced fit and lock and key) - Monomeric, Oligomeric and multienzyme complex, isozymes and allosteric enzymes

Unit 2 : Vitamins as Coenzymes

Fat soluble and water soluble vitamins - Role of vitamins as coenzymes for enzyme catalyzed reactions in different metabolic pathways - Digestion and absorption of carbohydrates, proteins and lipids.

Unit 3 : Enzyme Kinetics

Derivation of Michaelis - Menton equation and its significance in enzyme kinetic studies - Lineweaver-Burke 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.

Unit 4: Immobilization Techniques

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.

Unit 5 : Biosensors and Probes

Definitions and History - Sensors based on: enzymes, affinity and wholecells - Transducers: electrodes, photometric and acoustics - Immobilizations techniques: thin films, micro and nano-structures - immunosensors - Novel transducers and synthetic receptors - Clinical, environmental, industrial and military applications - biochips, biofilms and biosurfactants, 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 Applications, John 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. Verlag Chemie.
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.

FDIM3E2 – Elective 2 : FUNDAMENTALS OF IMMUNOLOGY

Number of Hours / Week: 4

Credits: 4

Unit 1: Immune System

History of immunology, immunity - innate immunity, acquired immunity; immunohematology – 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

Unit 2: Antigens and Antibodies

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.

Unit 3: Immune Responses and Antigen-Antibody Reactions

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, immunofluorescence, 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

Unit 4: Immunology of Transplantation and Malignancy

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, Immunohematology- ABO and Rh blood group system, Immunology of blood transfusion, Hemolytic disease of new born.

Unit 5: Immune System Disorders and Deficiencies

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

FDIM3E3 – Elective 3 : MICROBIAL ECOLOGY

Number of Hours / Week: 4

Credits: 4

Unit 1 : Microbiology of Air

Aerobiology – Density of microorganisms in air – Outdoor and 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

Unit 2 : Microbiology of Water

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

Unit 3 : Microbiology of Soil

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 Azospirillum, Azotobacter, Azolla*, Blue Green Algae - mass production methods - applications methods of biofertilizers - significance of biofertilizers

Unit 4 : Ecological Groups and Microbial Interactions

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 – Mycorrhizza – Nematophagous fungi - Nitrogen fixation : Symbiotic and free living nitrogen fixers - Biological Nitrogen fixation - Phosphate solubilizers

Unit 5 : Microbial Transformation and Degradation of Toxic or Organic Chemicals

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.

FDIM3E4 – Elective 4 : BASICS OF ENVIRONMENTAL SCIENCE

Number of Hours / Week: 4

Credits: 4

Unit 1 : Principles and Scope of Environmental Science

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.

Unit 2 : Ecology and Evolution

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

Unit 3 : Biodiversity and its Management

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.

Unit 4 : Environmental Pollution

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

Unit 5 : Environmental Impact Analysis

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.

FDIM3E5 - Elective 5 : ESSENTIALS OF FOOD SCIENCE

Number of Hours / Week: 4

Credits: 4

Unit 1 : Science of Various Food Types : Cereals and Pulses

Cereals – Rice and wheat, other Millets - Composition and Nutritive Value - Starch - Sources, Characteristics, Principles of Starch cookery - Batter and Dough - Structure, Principle, Properties, Different types of flour, Gluten - properties, Gluten formation - Flour : Types, properties - Bread - yeast leavened, Quick bread, pastries, cakes - Role of ingredients and preparation. - Pulses - Composition, types, Cooking methods, factors affecting cooking quality, nutritive value, toxic constituents and its removal, Germination and factors affecting Germination

Unit 2 : Vegetables and Fruits

Vegetables - Structure, Classification, Composition, Methods of Cooking, Changes on Cooking (pigments, nutritive value) - Fruits - Structure, Classification, Composition, Ripening of fruits, changes on ripening, Pectic substances, Cooking changes.

Unit 3 : Egg, Meat and Fish

Egg - Structure, Composition, Nutritive value, Grading, Methods of Cooking and Role of egg in cookery - Meat - Structure, Composition, Nutritive value, Classes and Grades of meat cuts, Changes on cooking and Rigor mortis. Poultry - Composition, Nutritive value, Grades, Methods of cooking, Effects of cooking - Fish - Composition, Nutritive value, Types, Cuts, Selection, Spoilage, Cooking and Factors effecting cooking quality

Unit 4 : Milk and Milk products

Milk and Milk Products - Composition, Nutritive value, Constituents - Properties of milk - Effects of acid, Salt, Heat on milk proteins and coagulation - Milk products - Ice cream, Types, Crystal formation and Dairy forms.

Unit 5 : Miscellaneous Food Types

Fats and Oils - Types properties of fat relating to cooking - Rancidity, Tests for rancidity – Hydrogenation - Changes in fat during heating - Factors affecting fat absorption, Shortening, Use of fat in tenderness of cooked products - Sugar - Types of sugar, Properties, Crystallization, Stages in Sugar cookery, Application in Indian recipes - Beverages - Classification, Nutritive value, Preparation of milk based beverages - Spices and Condiments - Uses and abuses.

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, Sakuntala Manay and Shadaksaraswamy, M (1987) Allied Publishers, New Delhi.
8. Food science, Potter N.N. (1996) CBS publishers & distributors, Delhi.

FDIM3P3- LABORATORY COURSE III

(Based on **FDIM309 - Microbial Processes and Products** and **FDIM310 – Microbial Contamination, Spoilage and Preservation of Foods**)

Credits 4

Microbial Processes and Products

1. Bioprocess engineering lab
2. Screening of Process variables : Plackett-Burman design practice
3. Demonstration of reactor studies : Batch, fed-batch, and continuous flow reactor analysis and residence time distribution.
4. Determination of Thermal Death Point (TDP) and Thermal Death Time (TDT) of microorganisms for design of a sterilizer.
5. Monitoring of dissolved oxygen during aerobic fermentation.
6. Preservation of industrially important bacteria by lyophilization.
7. Product concentration by vacuum concentrator
8. Cell disruption for endoenzymes by sonication.
9. Mushroom cultivation and its analysis.
10. Production of wine from grapes

Microbial Contamination, Spoilage and Preservation of Foods

1. Biochemical tests for identification of bacteria : Sugar fermentation, IMViC test, H₂S production, nitrate reduction, starch hydrolysis, oxidase, catalase
2. Enumeration of coliforms; Bacteriological examination of water by multiple tube fermentation test or multiple tube test or MPN
3. Quantitative estimation of microorganism: Serial dilution technique; Pour plate Spread plate technique
4. Conventional and rapid methods of isolation and identification of pathogenic bacteria, fungi.
5. Enrichment and Selective isolation of *Salmonella*, *Shigella*, *Staphylococcus aureus* from spoiled or contaminated foods
6. Bacteriological analysis of milk : by MBRT; mastitis test for milk.
7. Determination of spoilage by Microbiological methods for meat, fish, dairy, fruits, vegetables, cereals, poultry – by TPC, indicator bacteria and pathogens, MBRT

SYLLABUS

Fourth Semester M. Sc. Food and Industrial Microbiology

FDIM411 - Core 11 : FOODS IN RELATION TO DISEASE

Number of Hours / Week: 4

Credits: 4

Unit 1 : Foodborne Diseases, their Surveillance and Detection

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 : *Entamoeba histolytica*, *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 and changing patterns in epidemiology - 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.

Unit 2 : Quality Evaluation of Foods

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

Unit 3: Food Laws and Standards

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 /USFDA/ISO 9000 series /ISO22000 and IS/ISO 22000 / Government regulatory practices and policies/FDA perspectives / PFA act and rules – Food Packaging and labelling

Unit 4 : Food Safety and Sanitation

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 -

Unit 5 : Quality Control and Quality Assurance

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 Nostrand, 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 Nostrand., 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.

FDIM412 - Core 12 : BIOSTATISTICS AND RESEARCH
METHODOLOGY

Number of Hours / Week: 4

Credits: 4

Unit 1 : Introduction to Biostatistics

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.

Unit 2 : Measures of Central Tendency

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.

Unit 3 : Tests of Significance

Tests of significance : Small sample test (Chi-square t test, F test), large sample test (Z test) and standard error. Introduction to probability theory and distributions, (concept without deviation) binomial, poisson 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 , Analysis of Variance (ANOVA) –one-way ANOVA – two- way ANOVA - correlation coefficient

Unit 4 : Research Methodology

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

Unit 5 : Scientific Writing and Presentation of Scientific Data

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 publications – 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.

FDIM4E6 - Elective 6: BIOSAFETY, IPR AND PATENTS

Number of Hours / Week: 3

Credits: 3

Unit 1 : Agricultural Biotechnology and The Society

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

Unit 2 : International Marketing and Trade

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 - Issues of product commercialization : Product promotion, price, distribution channels - Problems related to trade of biological items - Sanitary and Phyto-sanitary measures - Technical barrier to trade and AOA

Unit 3 : Regulatory Practices

Financing Rand D capital and market outlook - IP, BP, SP - Government regulatory practices and policies - FDA perspective - Reimbursement of drugs and biologicals, legislative perspective - GATT and TRIP

Unit 4 : Intellectual Property Rights and Patents

Concept of Patents, Copyrights, Trademarks - Need for patents, Procedure for patent application - International harmonization of patent laws - Patenting of life forms - plant, animals, microbes, gene, process and products - Plant Variety Protection Act - Plant Breeders Rights - Regulatory issues and Challenges to food products, patent process, protection of knowledge, knowledge consortia and databases

Reference Books

1. Gupta P.K. (2003), Biotechnology and Genomics, Rastogi Publications Meerut
2. Stewart-tull, D.E.S. & Sussman, M(Eds.) 1994. The release of Genetically Modified Microorganisms, 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 biotechnology 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. 199

FDIM4E7 – Elective 7 : NEUTRACEUTICALS

Number of Hours / Week: 3

Credits: 3

Unit 1 : Classification

Definition, history, classification - Type of classification - Probiotics, Probiotics and Synbiotics - Nutrient Vs Non-Nutrient: according to target organ, according to source of origin

Unit 2 : Probiotics and Probiotic Foods

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

Unit 3 : Prebiotics and Prebiotic Foods

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.

Unit 4 : Food Components (others) with Potential Health Benefits

Polyphenols: Flavonoids - Catechins – flavones - tannins - Phytoestrogens - Phytosterols Glucosinolates - Pigments: Lycopene, Curcumin etc - Organo Sulphur Compounds - Other Components – Phytates - Protease inhibitions – saponins - amylase inhibitions-haemagglutinins - Active biodynamic principles in spices, condiments and other plant materials - Proteins, peptides and nucleotides - conjugated linoleic acid and n-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.

FDIM4E8 – Elective 8 : MEDICAL MICROBIOLOGY

Number of Hours / Week: 3

Credits: 3

Unit 1 : Biological properties and diseases caused by Gram positive bacteria (a brief account)

Corynebacterium, Staphylococcus, Streptococcus, Bacillus, Clostridium, Mycobacterium, Actinomycetes, Nocardia

Unit 2 : Biological properties and diseases caused by Gram negative bacteria (a brief account)

Neisseria, Fusobacterium Escherichia, Klebsiella, Proteus, Salmonella, Shigella, Vibrio, Campylobacter, Pseudomonas, Acinetobacter, Yersinia, Francisella, Pasteurella, Haemophilus, Bordetella, Mycoplasma, Spirochetes, Rickettsiae, Chlamydiae

Unit 3 : Biological properties and diseases caused by viruses (a brief account)

Pox, Herpes, Adeno, Entero, Myxo, Arbo, Rhabdo, Hepatitis, Oncogenic and Human Immunodeficiency Viruses

Unit 4 : Biological properties and diseases caused by Fungi and Protozoa (a brief account)

Trichophyton, Microsporum, Sporotrichosis, Candidiasis and Aspergillosis- Entamoeba histolytica, Giardia lamblia, Trichomonas, Trypanosomes, Leishmania, Cryptosporidium, Plasmodium, Toxoplasma and Pneumocystis

Recomonded 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.

FDIM4P4- LABORATORY COURSE IV

(Based on FDIM411 – Foods in Relation to Diseases and FDIM412 – Biostatistics, Computer Applications And Research Methodology)

Credits 4

Foods in Relation to Diseases

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, multiple comparison test, paired comparison test,
4. Chemical evaluation- Moisture, PR, HM, TVBN, Peroxide value, Acidity/ acid value detection of adulterants
5. Microbiological evaluation : Enumeration of coliforms, MPN, TPC

Biostatistics, Computer Applications And Research Methodology

1. Application of mean, median, mode
2. Computer oriented statistical analysis - t test, Chi-square t test, Standard deviation, ANOVA
3. Word processing commands using MS-Word.
4. Mail Merge facility of MS-Word.
5. Graphical presentation using MS-Excel.
6. Creation of Data tables in MS Access and simple queries with SQL.
7. Online Bibliographic and patent search.
8. Sequence information resource
9. Understanding and using on web: Embl, GENbank, Entrez, Unigene
10. Understanding and using on web: PDB, Swissprot, TrEMBL
11. Using BLAST and interpretation of results
12. Multiple sequence alignment using ClustalW
13. Construction of phylogenetic tree

FDIM4D : PROJECT

Credits: 4

Each candidate will carry out a four months project work in an industry/ R&D organization or in the department and submit a report on his/ her work. The project work should be focussed on a topic related to the syllabus of the course. The candidate will submit three bound copies of the project work performed by him/her duly certified by the guide/supervisor. The project report should cover the summary, introduction, materials and methods, objectives, results, discussion and references. The references will be arranged alphabetically under the format given below:

Referred Journal

Bhalla T. C., Sharma N. N. and Sharma M. (2006). Expression of alkaline protease in *Rhodococcus* sp. *Journal of Applied Biotechnology* 32: 225-230.

Book

Demartino G. N. (1996). Purification of proteolytic enzyme. In: *Proteolytic enzyme: a practical approach*. Berjnon RJ and Bond JS eds, IRL Press, NewYork.

Thesis

Verma M. L. (2006). Production, purification and characterization of thermotolerant *P. aeruginosa* lipase. PhD Thesis, Himachal Pradesh University, Shimla, India.

Website

www.elsevier.com

FDIM 4V : COURSE VIVA

Credits: 3

The candidate will undergo a course viva spanning the entire syllabus of the course in the fourth semester.