

ANNAMALAI UNIVERSITY
MASTER OF SCIENCE
M.Sc. Applied Microbiology
(2020 – 2021)

The Course of Study and the Scheme of Examination

Sl. No.	Study Components		ins. hrs / week	Credit	Title of the Paper	Maximum Marks		
	Course Title					CIA	Uni. Exam	Total
SEMESTER I								
1	Core	Paper-1	5	4	General Microbiology and Microbial Physiology	25	75	100
2		Paper-2	5	4	Immunology and Immunotechnology	25	75	100
3		Paper-3	4	4	Food and Dairy Microbiology	25	75	100
4		Practical-1	10	5	Lab Course - 1	50	150	200
Internal Elective for same major students (Choose any one)								
5	Core Elective	Paper-1	3	3	A. Computational Biology B. Algal Technology C. Biosafety	25	75	100
External Elective from other major departments (Inter/multi disciplinary papers)								
6	Open Elective	Paper-1	3	3	A. Microscopic Techniques B. Basics of Microbiology C. Molecular Biology	25	75	100
			30	23		175	525	700
SEMESTER II								
7	Core	Paper-4	5	4	Medical Bacteriology and Mycology	25	75	100
8		Paper-5	5	4	Industrial Microbiology	25	75	100
9		Paper-6	4	4	Molecular Biology and Microbial Genetics	25	75	100
10		Practical-2	8	5	Lab Course - 2	50	150	200
Internal Elective for same major students (Choose any one)								
11	Core Elective	Paper-2	3	3	A. Mushroom cultivation B. Biofertilizer Technology C. Intellectual Property Rights	25	75	100
External Elective for other major departments (Inter/multi disciplinary papers)								
12	Open Elective	Paper-2	3	3	A. Food Processing Technology B. Infectious Diseases and its Control C. Microbial Ecology	25	75	100
13	*Field Study	-	-	2	-	100	-	100
14	Compulsory Paper		2	2	Human Rights & Duties	25	75	100
			30	27		300	600	900

*** Field Study**

There will be field study which is compulsory in the first semester of all PG courses with 2 credits. This field study should be related to the subject concerned with social impact. Field and Topic should be registered by the students in the first semester of their study along with the name of a mentor before the end of the month of August. The report with problem identification and proposed solution should be written in not less than 25 pages in a standard format and it should be submitted at the end of second semester. The period for undergoing the field study is 30 hours beyond the instructional hours of the respective programme. Students shall consult their mentors within campus and experts outside the campus for selecting the field and topic of the field study. The following members may be nominated for confirming the topic and evaluating the field study report.

- (i). Head of the respective department
- (ii). Mentor
- (iii). One faculty from other department

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SEMESTER I

CORE PAPER – 1
GENERAL MICROBIOLOGY AND MICROBIAL PHYSIOLOGY

UNIT-I - Discovery of Microbial world – Contribution of various scientists; General characteristics used in classification, five kingdom, six kingdom, and eight kingdom concept. Evolutions of Microbiology with its recent developments in Medicine. Microscopy - Principles and applications, Simple, Compound, Dark field, Phase contrast, Fluorescent and Electron Microscopes (SEM & TEM); Stains and Dyes - Staining methods - Gram, Acid Fast, Staining of flagella, Metachromatic granules, capsule, other special staining methods - silver impregnation. Bacterial morphology, structure and characterization - cellular components of bacteria

UNIT-II - Sterilization (Heat, Filtration) and Disinfection methods and their quality control. - sporulation and its mechanics - growth and nutrition - Nutritional requirements - Autotrophs, heterotrophs - enrichment culture - growth curve - Kinetics of Growth - Mathematical expression of exponential growth phase; Measurement of growth and growth yields - Batch Culture - Synchronous growth - Techniques of pure culture.

UNIT-III - Classification of bacteria and salient features according to Bergey's manual of determinative Bacteriology. Microbial diversity in different ecosystems. . Modern trends in microbial taxonomy. Specialized somatic Structure and Classification of fungi. Reproduction in fungi - Life cycles of fungi.

UNIT-IV - Structure and function of viruses - classification of viruses - replication of viruses – bacteriophages. Structure and Classification of Algae - ultrastructure and life histories of microalgae belonging to various algal classes. Cyanobacteria. Protozoa - Structure and Classification.

UNIT-V - Basic concepts of metabolism. Carbohydrate metabolism - Glycolysis - HMD, TCA & ED and other pathways. Aerobic and anaerobic respirations - Generation of energy - substrate level and oxidation phosphorylation - Electron transport chain - Lipid metabolism - Beta oxidation - proteins - primary, secondary, tertiary and quaternary structures - photosynthesis - cyclic and non -cyclic photophosphorylation.

Text Books

1. Pelczar & Kreig (2006). Microbiology 5th edition. Tata McGraw Hill, New Delhi.
2. Dubey RC and Maheswari DK (2005). A text book of Microbiology, Revised Multicolour edition, S.Chand Publishers, New Delhi.
3. Prescott, L. M., J. P. Harely and D. A. Klain, Microbiology, 2003 (5th Edition) McGraw Hill, New York.

Reference Books

1. Salle, AJ (2001). *Fundamentals & Principles of Bacteriology*. 7th edition. Tata McGraw-Hill, Davis.
2. Atlas R. A. *Principles of Microbiology* (2nd Edition), 1997. Wm. C. Brown Publishers, Iowa.
3. Elizabeth Moore-Landecker. (1996). *Fundamentals of the fungi*. (4th edition). Prentice Hall International, Inc, London.
4. Conrat HF, Kimball PC and Levy JA. (1988). *Virology*. II edition. Prentice Hall, Englewood Cliff, New Jersey.
5. Delbecco, Eisen & Ginsburg (1990) *Microbiology* 5th Edition Harper & raw, New York

SEMESTER I

CORE PAPER – 2

IMMUNOLOGY AND IMMUNOTECHNOLOGY

Course Objectives

1. To procure knowledge on the basic principles and definitions of immunology, its modern achievements and practical ways of implementation.
2. To impart knowledge about the underlying concepts of molecular and cellular mechanisms involved in the development and regulation of the immune response.
3. To learn the important concepts in Major histocompatibility and Hypersensitivity Reactions
4. To understand about autoimmune diseases and the principles behind immunomodulation.
5. To acquire skills and competence in specialized immunological techniques in the diagnosis and management of health related disorders and about tumor immunology.

Unit 1: Cells and Organs of the Immune System

Immune system and Immune Response: Innate and acquired immunity; structure and functions of immune cells - T cells, B cells, Macrophages, NK cells and dendritic cells, Eosinophils, Neutrophils, Mast cells; Organs of immune system - Primary and secondary lymphoid organs; Primary and secondary immune response; Clonal selection theory.

Unit 2: Antigen and Antibodies

Structure and properties of antigens – Iso- and allo-antigens - antigen specificity, Haptens and adjuvants- structure and properties; Immunoglobulins – Structure, properties, types and subtypes; Generation of immunological diversity; Complement system- component, properties and functions. Complement pathways and biological significance.

Unit 3: Major Histocompatibility Complex and Hypersensitivity Reactions

Major Histocompatibility Complex - Structure and functions of MHC and HLA systems; Genetic control of immune response; Tissue transplantation - Tissue typing methods for tissue and organ transplantations. Graft versus host reaction and rejection, xenotransplantation, immunosuppressive therapy; Hypersensitivity Reactions - Allergy, Hypersensitivity reactions- types (I, II, III, and IV), symptoms, immunodiagnosis. Lymphokines and cytokines - Interleukins and Interferons - Production, biological functions and assay methods; Immunological tolerance.

Unit 4: Autoimmunity and Immunomodulation

Autoimmunity- Autoimmune diseases – Hashimoto's disease, Systemic Lupus Erythematosus, Multiple sclerosis, Myasthenia gravis and their treatment; Immunomodulation (immunosuppression & immunostimulation), Immunotherapy, lymphocyte migration - homing and trafficking, antigen-induced lymphocyte proliferation, Granulysin mediated anti-microbial activity of T cells.

Unit 5: Immunological Techniques and Tumor immunology

Immunological Techniques: Agglutination, precipitation, immunofluorescence, immunoelectrophoresis, immunoblotting, ELISA, RIA, Flow cytometry. Production and purification of antibodies, determination of antibody titre by RID and EID. Tumor Immunology: Tumors of the Immune System, Tumor Antigens, Immune Response to Tumors, Tumor Evasion of the Immune System, Cancer Immunotherapy.

Text Books

1. Roitt I., Essential Immunology, 13 th edition, Blackwell Scientific Publications, 2017.
2. William E. Paul. Fundamental Immunology, Lippincott Williams and Wilkins; 7th edition, 2012.
3. Anathanarayanan and Paniker, Text Book of Microbiology, 8th edition, Orient and Longman, New Delhi, 2009.

Reference Books

1. Kuby, Judy Owen, Jenni Punt, Sharon Stanford., Immunology, WH Freeman Publishers,7th Edition 2012.
2. Weir DM and Stewart, J.,Immunology, 10th Edn., Churchill Livingstone, New York, 2000.
3. Tizard, Ian R., Immunology- An Introduction, 4th edition, Saunders College Publishing, New Delhi.
4. Sunil Kumar Mohanty, K Sai Leela., Textbook of Immunology, 2nd Edition, Jaypee Brothers Medical Publishers, 2014.
5. Mark Peakman and Diego Vergani. 1st magazine, 1997, Basic and Clinical Immunology. Churchill Livingstone, New York.

SEMESTER I

CORE PAPER – 3

FOOD AND DAIRY MICROBIOLOGY

UNIT I - Microorganisms important in food microbiology

Food as a substrate for microbes. Microorganisms important in food microbiology. Factors influencing microbial growth in food. Extrinsic and Intrinsic factors. Sources of food contamination.

UNIT II Principles of food preservation

Principles of food preservation, General principles and application methods –Asepsis - Techniques of removal –use of temperature (low & high). Drying, High pressure radiation and chemical preservatives.

UNIT III Contamination, preservation and spoilage and fermented foods

Contamination, preservation and spoilage of fruits, vegetables, meat, poultry, eggs, fish and other sea foods. Canning - Methods - Types - Spoilage of canned foods. Fermented foods – Bread and Malt beverages – Beer, Wine , Vinegar. Fermented vegetables. Nutritional value of fermented foods.

UNIT IV - Dairy Microbiology

Dairy Microbiology: Micro flora of milk. Sources of milk contamination. Preservation and spoilage of milk and milk products. Microbiology of fermented milk products -Acid fermented milks (acidophilus milk, yoghurt). Slightly acid fermented milks (Cultured butter milk), Acid-alcoholic fermented milk (Kefir). Fermented Fermented foods - Fermented vegetables and dairy products. Milk production with extended self life (labneh).

UNIT V - Foodborne diseases and their control

Food borne diseases, food intoxication and their control measures - Food sanitation in food manufacture and in the retail trade. Food control agencies and their regulations. HACCP, GMP, GHP.

Text Books

1. Frazier W. C. and D.C. Westhoff, Food Microbiology, 1988 (4th Edition), Tata McGraw Hill Publishing Company Ltd., New Delhi.
2. Moss. M. R., and M. O. Moss, Food Microbiology, 1996. New Age International (P) Limited Publishers, New Delhi.
3. J.B. Prajapati. 1995. Fundamentals of Dairy Microbiology. Akta Prakashan Publisher.

Reference Books

1. Banwart, G. J. Basic Food Microbiology, 1989, CBS Publishers and Distributors, New Delhi.
2. Jay, J. M., Modern Food Microbiology. (4th Edition), 1996, CBS Publishers and Distributors.
3. Milk and Milk Products. Eckles C.H., Combs W.B. and Macy H. 1998. Published by Tata McGraw Hill Publishing Co Ltd.
4. Narayanan, R. and B. Dhanalakshmi. 2013. Food Microbiology: Basic and Applied With Laboratory Exercises. NIPA Publishers.
5. A. Bohra and Pradeep Parihar. 2006. Food Microbiology. Agrobios, Jodhpur.

Internal Elective for same major students

Semester I A. Computational Biology

Unit I: Introduction to computers – Types of computers – Generation – Applications of computers – Input and Output devices – ROM, RAM- Internet.

Unit II: Data-alignment and applications; Collecting and Storing Sequence Data; Sequence assembly; Submission of Sequences; Sequence accuracy; Sequence databases; Sequence formats; Conversion between formats; Scoring matrices; Homology and related concepts; Dot Matrix methods; Dynamic programming methods for global and local alignments tools- BLAST.

Unit III: Nucleic acid sequence analysis: Reading frames; Codon Usage analysis; Translational and transcriptional signals; Splice site identification; Gene prediction methods; RNA fold analysis.

Unit IV: Basic structure and building blocks of proteins; motifs of protein structures; alpha/beta structures; Folding and flexibility, Prediction, engineering and design of protein structures; Methods to identify secondary structural elements.

Unit V: DNA microarray: database and basic tools, Gene Expression Omnibus (GEO), ArrayExpress, SAGE databases; understanding of microarray data, normalizing microarray data, detecting differential gene expression, correlation of gene expression data to biological process and computational analysis tools. **Protein arrays:** basic principles, bioinformatics-based tools for analysis of proteomics data (Tools available at ExPASy Proteomics server); databases (such as InterPro) and analysis tools; Protein-protein interactions.

Text Books

1. An introduction to bioinformatics algorithms by Neil C. Jones, Pavel Pevzner. MIT Press. 2004.
2. Bioinformatics: Sequence and Genome Analysis by Mount D., 2004 Cold Spring Harbor Laboratory Press, New York.

Reference Books

1. Bioinformatics- a practical guide to the analysis of Genes and Proteins by Baxevanis, A.D. and Francis Ouellette, B.F., 1998, John Wiley & Sons, UK.
2. Bioinformatics: the machine learning approach by Pierre Baldi, Søren Brunak. MIT Press. 2001.
3. Cynthia Gibas and Per Jambek. Developing Bioinformatics computer skills, Shroff publishers and Distributors Pvt. Ltd., O' reilly, Madurai. 2001.

Semester I B. Algal Technology

Unit I: Introduction to algal technology; Characteristics and classification of Algae (Outline only) - Chemical composition - protein, amino acids, lipids, waxes, glycerol, vitamins, pigments, chlorophyll, carotenoids and phycobiliproteins. Distribution of economically important algae in India.

Unit II: Characteristics, significance and Uses of the following algae - *Dunaliella*, *Haematococcus*, *Chlorella*, *Scenedesmus*, *Botryococcus*, *Porphyridium*, *Gracilaria*, *Gelidium*, *Gelidiella*, *Laminaria*, *Porphyra*, and *Ulva*.

Unit III: Algal production systems; Strain selection; Algal growth curve; Culture media; indoor cultivation methods and scaling up; Measurement of algal growth; Large-scale cultivation of algae; Harvesting algae. Drying; Algal immobilization and its applications

Unit IV: Algae as a source of food and feed; Algae as SCP - *Spirulina* mass cultivation and its applications, Algae as a source of pigments, fine chemicals and bio-fertilizers; Blue-green algal bio-fertilizer - Method of preparation, application and its advantages over inorganic fertilizers; Liquid seaweed fertilizer - Method of preparation and application. Biodiesel from algae; Phycoremediation; Role of algae in nanobiotechnology.

Unit V: Algal control - Methods of control of algae; Algicides-preparation and Application; ultrasonic sound producing devices to control algae; Algal culture collection centers in India and abroad and their importance; Centers pursuing algal research in India and their field of interest.

Text Books

1. TRIVEDI, P.C. 2001 Algal Biotechnology. Pointer publishers, Jaipur, India.
2. BARSANTI, LAURA AND PAOLO GUALTIERI 2005 Algae-Anatomy, Biochemistry and Biotechnology. Taylor & Francis, London, New York.

Reference Books

1. Borowitzka MA and Borowitzka LJ. Microalgal Biotechnology, Cambridge University Press. 1989.
2. BECKER, E.W. 1994 Microalgae-Biotechnology and microbiology. Cambridge University Press.
3. Das Mihir Kumar. Algal Biotechnology. Daya Publishing House.

Semester I C. Biosafety

Unit I: Biosafety: Introduction – Historical background - Biosafety issues in Microbiology - Disease transmission and epidemiology - Levels of Specific Microorganisms, Infectious Agents and Infected Animals - Aseptic technique - Standard Microbiological Practices.

Unit II: Biohazards: Definition of GMOs & LMOs; rDNA technology - GMO applications in food and agriculture - Environmental release of GMOs - Risk - Analysis, Assessment, management and communication - Hazardous Wastes in Biological Labs – Types and Management - Bioterrorism

Unit III: Biocontainment: Concepts and Strategies – Risk Groups (from NIH Guidelines) and Biosafety Levels (from CDC Biosafety) - Biological Safety Cabinets - Primary Containment for Biohazards - Animal Biosafety and Facilities - Operations and Maintenance of Biosafety Facilities.

Unit IV: Biosafety Management: Risk Assessment - Risk Communication - Warning Signs and Labels - Working Safely with Biohazardous Agents - Disinfection and Decontamination procedures - Emergency Planning and Response - Personal Protective Equipment.

Unit V: Biosafety Guidelines: Guidelines and regulations (National and International) - Cartagena Protocol; Institutional Biosafety Committee (IBSC) - Composition and role; Role of review committee on genetic manipulation (RCGM) and GEAC; Transportation of Infectious Substances.

Text Books

1. Jonathan, Y.R., Anthology of Biosafety (Vols. 1-4), American Biological Safety Association (2005).
2. Sateesh, M.K., Bioethics and Biosafety, IK International Publishers (2008)

Reference Books

1. Biosafety and bioethics (2006) Rajmohan Joshi. Gyan Publishing House.
2. Microbial Biotechnology & Biosafety Aspects P. Palanivelu. Twentyfirst Century Publications. 2016
3. Biological Safety: Principles and Practices. American Society for Microbiology. 2017. Editors: Dawn P. Wooley and Karen B. Byers.

External Elective for other major departments (Inter/multi disciplinary papers)

SEMESTER I A. Microscopic Techniques

UNIT-I: Introduction of Microscope – Microscopic properties of light- Resolution, Image formation by convex lens, lens aberrations - Spherical chromatic, Ocular-Manipulating the light within the Microscope.

UNIT –II: Light Microscope, Bright field Microscope, Dark field Microscopy; Slide preparation - Fixation -Staining of sample Technique - Mounting of sample - Labelling and storage of slides - Application in biological science.

UNIT-III: Phase contrast Microscopy, Fluorescence Microscope - slide preparation - fixation-staining of sample technique - mounting of the sample - labelling and storage of slides- Application in biological sciences.

UNIT-IV: Electron Microscopy - Electron beam Principle - Construction and working of TEM (Transmission of Electron Microscope), SEM (Scanning Electron Microscope) with their merits limitations and their Application.

UNIT- V: Atomic Microscopy working of AFM (Atomic Force Microscope) and STM (Scanning Tunnelling Microscope) with their merits limitations and their Applications. Confocal Microscope techniques.

Text Books

1. Murphy, Douglas and Davidson, Michael - Fundamental of light Microscopy and electronic imaging, second edition. Wiley-Blackwell. 2013.
2. Cruycox, optical imaging Techinques in Cell Biology. CRC press. 2007.

Reference Books

1. Paurley, J.B.(ed). Handbook of Biological Confocal Microscopy, Second edition. 1995 Newyork Plemum Press.
2. Jmwalls, Editor, method of surface analysis: Techniques and application. Cambridge University Press 1990
3. Fundamentals of Light Microscopy and Electronic Imaging. Ed. by Douglas B. Murphy and Michael W. Davidson. 2001. Wiley and Blackwell.

SEMESTER I B. Basics of Microbiology

UNIT – I: Introduction to Microbiology; Five major groups of Microorganisms; Scope of Microbiology; Spontaneous generation; Brief note on the contributions of Jenner, Louis Pasteur, Robert Koch and Alexander Flemming.

UNIT – II: Microscopy – Microscopes - principles and applications – Bright field, Dark field, Fluorescent, Phase contrast & Electron Microscope (TEM and SEM); Morphology of Bacteria – size, shape and arrangement; Structure and function of bacterial cell organelles; Stains and staining techniques – simple, Grams, acid fast and special staining – flagella, capsule, metachromatic granules.

UNIT – III: Algae - Structure and classification (outline only); Specific examples – Microalgae, Cyanobacteria; Cultivation of algae; Algal toxins; Uses and significance of algae. **Fungi** – General characteristics, morphology and reproduction; Classification (outline only); Culturing fungi; Fungal diseases; Industrial uses of Fungi.

UNIT – IV: Protozoa - General characteristics, morphology, reproduction and classification (outline only); Life cycle of Plasmodium as an example; Protozoan diseases.

UNIT – V: Viruses - General characteristics, morphology, multiplication and classification (outline only); Plant, Animal and Human viruses; Virus cultivation methods; Viral Diseases; Bacteriophages.

Text Books

1. Pelczar J.R., Chan E.C.S., and Krieg R., Microbiology, 5th Edition, Tata McGraw – Hill publish company limited, Delhi, 2004.
2. Rajan. S and Selvi Christy (2015). Essentials of Microbiology, Anjanna Book House Publishers, Chennai.

Reference Books

1. Prescott, L. M., J. P. Harely and D. A. Klain, Microbiology, 2003 (5th Edition) McGraw Hill, New York.
2. Atlas R. A. Principles of Microbiology (2nd Edition), 1997. Wm. C. Brown Publishers, Iowa.
3. Heritage, J. Evans E.G.V. and Killington, R.A. (1996). Introductory Microbiology. Cambridge University Press.

SEMESTER I C. Molecular Biology

Unit I: Central Dogma – Concept of genes - Nucleic Acids – Components of Nucleic acids – The double helix – Circular and superhelical DNA – Determination of the base sequence of DNA

Unit II: Structure of RNA – Methods used to study macromolecules – Isolation of nucleic acids - Proteins - Chemical and Physical structure of a polypeptide chain

Unit III: DNA replication – the basic rule for replication of all nucleic acids – Discontinuous replication – Bidirectional replication – Rolling circle replication – DNA damage and repair – Mutations and Mutants — Mutagenesis – Reversion – Suppression

Unit IV: Plasmids - Types – properties of particular bacterial plasmids - Transposable elements – Transposons and evolution - Molecular aspects of gene expression – Transcription – messenger RNA – Translation – the genetic code – the operon model

Unit V: Bacterial Transformation – the discovery of transformation - Bacterial Conjugation Bacteriophages – Phage genetics - Lysogeny – Transduction – DNA transfer by means of transduction – Genetic related diseases

Text Books

1. Friefelder D. (1995). Molecular Biology, 2nd Edn. Narosa Publishing House.
2. Weaver. R. F. Molecular Biology. 3rd ed. Mc Graw Hill publilcation , 2005.

Reference Books

1. Russel Peter. Essential Genetics. 2nd Edn, Blackwell Science Pub.
2. Alberts Bruce (2008) Molecular Biology of Cell, 5th Ed. Garland Pub.
3. Watson. J. D, Baker. T. A, Bell. S. P, Gann. A, Levine. M, Losick. R. Molecular Biology of Gene. 5th The Benjamin / Cummings Pub. Co. Inc, 2003

SEMESTER – I Lab course - 1

General Microbiology

Principles and methods of sterilization – Autoclave, Hot air oven
Direct microscopic observations of yeast budding
Staining methods - Simple, Gram staining, Negative, spore, Capsule staining
Preparation of Culture Media - Broth, Agar, plates, slants, soft agar
Pure culture techniques - Streak plate
Measurement of size of microbes – micrometry
Motility determination – Hanging drop method
Total count - Haemocytometer
Microscopic observation of fungi - Lactophenol cotton blue staining
Biochemical tests for bacterial identification

Immunology

Quantification of Blood cells using Haemocytometer
Precipitation on gels – Single radial Immuno diffusion, Ouchterlony double diffusion
Widal test – slide, tube methods
Immunoelectrophoresis
VDRL test
Isolation of buffycoat

Food Microbiology

Detection of number of bacteria in milk by standard plate count (SPC)
Determination of quality of milk sample by methylene blue reductase test
Isolation and identification of bacteria from spoiled foods

SEMESTER II

CORE PAPER – 4

MEDICAL BACTERIOLOGY AND MYCOLOGY

On completion of the course the student is expected to be able to:

- Report for the structure, morphology and life cycle of medically relevant bacteria and eukaryotic microorganisms.
- Account for systematic of bacteria and classification of bacteria, especially the methods that are used for classification.
- Account for mechanisms of transmission, virulence, pathogenicity of pathogenic microorganisms and methods for treatment and prevention of medical important microorganisms.
- Account for the factors that influence the virulence of pathogenic microorganisms and how virulence evolves.
- The student able to understand diagnostic methodology for bacteria and fungi.

Unit I - History of Medical Bacteriology. Role of Microbiology in Medicine, Classification of medically important microbes, Normal Microbial flora, Infections- Source, Mode of transmission, etiology & epidemiology of nosocomial infections, Prevention of medically important microbes. Host-microbe interactions. Non specific defence mechanism- Mechanical barriers. Antibacterial substance.

UNIT-II - Morphological, cultural and biochemical characteristics , epidemiology, mechanism of bacterial pathogenesis, lab diagnosis, prophylaxis and control of medically important diseases caused by: *Staphylococcus*, Group A Streptococci, *Corynebacterium*, *Clostridium*, *Bacillus*, *Mycobacterium*, Atypical *Mycobacterium*, *Escherichia*, Klebsiella, *Salmonella*, *Shigella*, *Pseudomonas*, *Vibrio*, *Niesserriae*, *Haemophilus*, *Helicobacter*.

Unit III - Morphological, cultural and biochemical characteristics , epidemiology, mechanism of bacterial pathogenesis, lab diagnosis, prophylaxis and control of medically important diseases caused by: *Chlamydia*, *Rickettsia*, *Mycoplasma*, anaerobic bacteria, *Francisella*, *Brucella*, *Bordetella*, *Legionella*, *Listeria*, *Leptospira*, *Treponema*, Spirochaetes, Actinomycetes.

Unit IV - Introduction – characteristics of fungi- morphology-dimorphic fungi- classification of medically important fungi- laboratory diagnosis of fungal infections- antifungal agents- superficial cutaneous mycosis- Malessezia infections, Tinea nigra, Piedra, Dermatophytoses.

Unit V – Subcutaneous mycoses- Myotic mycetoma- systemic mycoses- histoplasmosis- Blastomycosis, coccidiomycosis, paracoccidioidomycosis- opportunistic systemic mycosis- aspergillosis, penicilliosis - yeast of medical importance- candida, Cryptococcus, mycotoxicoses.

Text Books

1. Ananthanarayanan R and Jeyaram Panicker CK. Medical Microbiology, Orient Publications, New Delhi.1990.
2. Jagadish Chander (1996) A Text Book of Medical Mycology. Interprint, New Delhi.
3. Brooks, G.F., Janet S. Butel, Stephen A, Jawwetz, Melnick & Adlerberg's Medical Microbiology, 21st Edition, Prentice Hall International Inc. 1998.

Reference Books

1. Murray. P.R., G.S, Kobayashi, M. A. Pfaller and K. S. Rosenthal, Medical Microbiology, 1993, (2nd Edition), Mosby St. Louis.
2. Greenwood, D., R.C.B. Slack, and J.F. Peutherer, Medical Microbiology 1997 (15th Edition), Churchill Livingstone. New York.
3. Mims, C.A., Mims' Pathogenesis of Infectious Diseases. 1995 (4th Edition), Academic Press, London.
4. Gerard J. Tortora, Berdell, R. Funke, Christine L. Case, , Microbiology: An Introduction.8th edition Hardcover: 944 pages, Publisher: Benjamin Cummings. 2004.
5. Kenneth J. Ryan,C. George Ray, John C. Sherris, Sherris Medical Microbiology : An Introduction to Infectious Diseases , Hardcover: 992 pages, Publisher: McGraw-Hill Professional, 2003.

SEMESTER II

CORE PAPER – 5

INDUSTRIAL MICROBIOLOGY

Course Objectives

1. To get equipped with theoretical and practical understanding of industrial microbiology.
2. To know how to source for microorganisms of industrial importance from the environment.
3. To know about design of fermentors, factors affecting growth and production.
4. To understand the rationale in medium formulation & design for microbial fermentation and to appreciate the different types of fermentation processes
5. To comprehend the techniques and the underlying principles in downstream processing.
6. To appreciate how microbiology is applied in the manufacture of industrially significant products.

Unit-1: Introduction to Fermentation Technology

Principles of fermentation process and its Historical back ground; Screening of microorganisms for primary and secondary metabolites, enrichment, random and strategic screening methods for the desired products; Isolation, selection and improvement of microbial cultures; Strain improvement of the selected organism. Types of fermentation processes - Aerobic and anaerobic fermentation, Batch fermentation, Continuous fermentation, Submerged fermentation, Surface or Solid State Fermentation (SSF).

Unit-2: Fermentor design and its types

Fermentors: basic features, design and components of a typical fermentor; Sterilization of fermentor, medium, air supply; Aseptic inoculation and sampling methods; Scale up of fermentation process; Types of Fermentors - Stirred tank reactors, Packed bed reactors, Fluidized bed reactors and Trickle flow reactors, Airlift bioreactor, Tubular bioreactors, Membrane bioreactors, Tower bioreactors, Fluidized bed reactor, Packed bed reactors, Cyclone reactors and Photo bioreactors.

Unit-3: Fermentation media and Fermentation process

Fermentation media: Natural and synthetic media; Strategies for media formulation; sources of carbon, nitrogen, vitamins, minerals; oxygen requirements; Role of buffers, precursors, inhibitors, inducers and antifoam agents. Fermentation process: kinetics of fermentation process; bioprocess control; monitoring of variables -temperature, agitation, pH and pressure.

Unit-4: Down Stream Processing

Downstream processing: Cell disintegration- Physical, chemical and enzymatic methods; Biomass separation by centrifugation, filtration and flocculation; Extraction - solvent, two phase, liquid extraction, whole broth and aqueous multiphase extraction; Purification – Chromatography, concentration, ultra-filtration, reverse osmosis, drying and crystallization, Solvent recovery; Quality control of fermented products.

Unit-5: Industrially important microbial products

Microbiological Production of: Alcohols – Ethanol, glycerol; Alcoholic beverages – Wine, Beer; Antibiotics - Penicillin, Streptomycin, Tetracycline; Vitamins - Vitamin C, Vitamin B12; Organic acids - citric acid, lactic acid; Amino acids – Lysine, glutamic acid; Microbial enzymes – amylases and proteases; Biodegradable plastic - polyhydroxyalkanoates (butyrate,

propionate); Microbial transformation of steroids; Immobilization of microbial cells and enzymes - methods and applications.

Text Books

1. Patel A.H. 2001. Industrial Microbiology. 3rd edition, Mac Millan India ltd, Chennai.
2. Casida J.E. 1986. Industrial Microbiology. 1st edition. Wiley Eastern publishers, UK.
3. D.K. Maheshwari, R.C. Dubey and S.C. Kang. 2006. Biotechnological Applications of Microorganisms - A Techno-Commercial Approach. I.K. International Publishing House Pvt. Ltd., New Delhi.

Reference Books

1. Doran P.M. 2013. Bioprocess Engineering Principles. Academic Press.
2. Waits, M.J., N.L. Morgan and G, Higton. Industrial Microbiology; An Introduction, 2001, Blackwell Science, Oxford.
3. Stanbury P.F., Whitaker A and Hall S.J. 2016. Principles of Fermentation technology. 3rd edition, Butterworth-Heinemann.
4. Fermentation Microbiology and Biotechnology. 2006. Second Edition. Edited by E. M. T. El-Mansi , C. F. A. Bryce , A. L. Demain and A. R. Allman. Taylor & Francis Inc.
5. Glazer A. N. and Nikaido H. Microbial Biotechnology: Fundamentals of Applied Microbiology, Second Edition. 2007. Cambridge University Press. Cambridge, UK.

SEMESTER II

CORE PAPER – 6

MOLECULAR BIOLOGY AND MICROBIAL GENETICS

Unit-I Structures of DNA and RNA / Genetic Material

DNA Structure: Miescher to Watson and Crick- historic perspective, DNA structure, Salient features of double helix, Types of DNA, Types of genetic material, denaturation and renaturation, cot curves. DNA topology -linking number, topoisomerases; Organization of DNA Prokaryotes, Viruses, Eukaryotes. RNA Structure, Organelle DNA -- mitochondria and chloroplast DNA.

Unit -II Replication of DNA (Prokaryotes and Eukaryotes)

Bidirectional and unidirectional replication, semi- conservative, semi- discontinuous replication Mechanism of DNA replication: Enzymes and proteins involved in DNA replication –DNA polymerases, DNA ligase, primase, telomerase – for replication of linear ends Various models of DNA replication including rolling circle, D- loop (mitochondrial), Θ (theta) mode of replication and other accessory protein, Mismatch and excision repair.

Unit –III Transcription in Prokaryotes and Eukaryotes

Transcription- promoter - concept and strength of promoter RNA Polymerase and the transcription unit .Transcription in Eukaryotes: RNA polymerases, general Transcription factors Post-Transcriptional Processing. Split genes, concept of introns and exons, RNA splicing, spliceosome machinery concept of alternative splicing, Polyadenylation and capping, Translation-Translational machinery, Charging of tRNA, aminoacyl tRNA synthetases, Mechanisms of initiation, elongation and termination of polypeptides. Regulation of gene Expression.

UNIT-IV History and cloning system

Historical perspectives - Synthetic DNA, DNA amplification technique - PCR. Preparation of genomic library, DNA library, gene cloning system, vectors, enzymes, expression system.

UNIT-V Application of genetic engineering

Application of genetic engineering in medical field - gene therapy, vaccines preparation, Hybridoma and monoclonal antibody techniques. ‘Nif’ gene - transfer - development of resistant plant variety, Application in Pharmaceuticals - antigens, interferons, vaccines, insulin, Social impact of recombinant DNA technology.

Text Book

1. Antony JF, Griffiths, Gilbert WM, Lewontin RC and Miller JH (2002). Modern Genetic Analysis, Integrating Genes and Genomes, 2nd edition, WH Freeman and Company, New York.
2. Blackburn GM, Gait MJ. (1996). Nucleic acids in chemistry and biology. Oxford University press.
3. Friefelder D. (1995). Molecular Biology, 2nd Edn. Narosa Publishing House.

Reference Books

1. Click. B.R. and-Pasternat J.J. (1994) Molecular Biotechnology. ASM press. Washington DC.
2. Benjamin Lewin (1997) Genes VI, Oxford University Press.
3. Watson JD, Hopkins NH, Roberts JW, Steitz JA, Weiner AM. (1998). Molecular biology of the gene, 4th edition, Benjamin/Cummings publishing company.
4. Old, R.S. and Primrose, S.B. (1995) Principles of Gene manipulation. An introduction to genetic Engineering. 5th Edition. Blackwell Scientific Publication, London.
5. Weaver. R. F. Molecular Biology. 3rd ed. Mc Graw Hill publilcation , 2005.

Internal Elective for same major students

Semester II A. Mushroom cultivation

Unit I: Introduction, History of Mushroom Cultivation- Morphology and life Cycle of Mushroom - Edible and Non-Edible Mushroom (Most commonly cultivated Mushrooms in the World, Distribution and Production in various Countries).

Unit II: Spawn; Types Spawn, Preparation of Spawn, Mushroom Bed Preparation and factors affecting Mushroom bed preparation, Compost: Materials used for Compost preparation , Compost Technology in Mushroom production- Casing; Raw material used for casing, preparation of Casing Material. Important Sanitation during various stages of Mushroom cultivation.

Unit III: Cultivation of important Mushroom: General process for the cultivation of *Agaricus bisporus* (White button Mushroom), *Pleurotus flabellus* (Oyster Mushroom), *Volvariella volvaceae* (Paddy Straw Mushroom).

Unit IV: Mushroom nutritional value; (Proteins, Amino acids , Vitamins, Minerals , Carbohydrates) -Pests and diseases of Edible Mushrooms (Environmental, Fungal, Bacterial, Viral, Insect Pests and Nematode diseases and competitor Moulds.

Unit V: Economics of mushroom cultivation (fixed assets, recurring expenditure, labour, economics of cultivation throughout the year and seasonal growing formulation of project report for getting finance from funding agencies). Precautions in mushroom cultivation (precaution to be taken while selecting the area, spawn preparation, spawn run, during cropping harvesting etc.). Mushroom recipes (Western and Indian recipes, pickles, powders, jams etc)

Text Books

1. Mushroom production and processing Technology, Pathak Yadav Gour (2010) Published by Agrobios (India).
2. Mushroom- the art of cultivation, Harander Sing (1991). Sterling Publishers.

Reference Books

1. Biology and conservation of mushroom, Kaul T N (2001). Oxford and IBH Publishing Company, New Delhi.
2. Changs. T.W.A. Hanyanes 1978. "Biology and cultivation of Mushrooms" Acad press. N.Y.
3. Zadrazil. F & K. Grabbe 1983 "Edible Mushroom, Biotechnology" Vol. 3, Weinheim: verlag Chemie, Berlin.

Semester II B. Biofertilizer Technology

Unit I: Introduction to biofertilizers - Characteristic features of the following biofertilizer organisms: Bacteria: *Azospirillum*, *Azotobacter*, *Bacillus*, *Pseudomonas*, *Rhizobium* and *Frankia*. Cyanobacteria: *Anabaena*, *Nostoc*, *Hapalosiphon*. Fungi: *Glomus*, *Gigaspora*, *Sclerocystis*, *Amanita*, *Laccaria*. Biofertilizers - Storage, shelf life, quality control and marketing; Advantages over chemical fertilizers.

Unit II: Biofertilization processes - Decomposition of organic matter; soil fertility, vermicomposting. Mechanism of phosphate solubilization and phosphate mobilization. Nitrogen fixation - Free living and symbiotic nitrogen fixation. Biotechnological application in nitrogen fixation.

Unit III: Nitrogenous Biofertilizers - Bacteria – Isolation, purification, mass multiplication, formulation of inoculums and application of inoculants of *Azospirillum* and *Azotobacter*; *Rhizobium* - Isolation, purification, mass multiplication, inoculum production, methods of application of *Rhizobium* inoculants.

Unit IV: Isolation and purification of Cyanobacteria. Mass multiplication of cyanobacterial bioinoculants - Trough or Tank method, Pit method, Field method; methods of application of cyanobacterial inoculum. *Azolla* - mass cultivation and application in rice fields.

Unit V: Mycorrhizae - Ecto and endomycorrhizae and their importance in agriculture. Isolation of AM fungi - Wet sieving method and sucrose gradient method. Mass production of AM inoculants and field applications. Isolation and Purification of phosphate solubilizers. Mass multiplication and field applications of phosphate solubilizer (*Pseudomonas striata*).

Text Books

1. Somani, L.L., S.C. Bhandari, K.K. Vyas and S.N. Saxena. 1990. Biofertilizers, Scientific Publishers - Jodhpur.
2. Tilak, K.V.B. 1991. Bacterial Biofertilizers, ICAR Pub., New Delhi.

Reference Books

1. Purohit, S.S., P.R. Kothari and S.K. Mathur, 1993. Basic and Agricultural Biotechnology, Agro Botanical Pub. India.
2. Bagyaraj, D.J. and A. Manjunath. 1990. Mycorrhizal symbiosis and plant growth, Univ. of Agricultural Sciences, Bangalore, India.
3. Subba Rao, N. S. 1988. Biological nitrogen fixation: recent developments, Mohan Primlani for Oxford and IBH Pub. Co. (P) Ltd., India

Semester II C. Intellectual Property Rights

Unit I: Introduction and the need for IPR - Introduction Concept and Origin of Industrial Designs – Introduction- evolution – Legal protection - Layout Designs – Integrated circuits – Utility Models – Protection of Industrial Designs. Major International Instruments concerning Intellectual Property Rights: Paris Convention, 1883, the Berne Convention, 1886, the Universal Copyright Convention, 1952, the WIPO Convention, 1967, the Patent Co-operation Treaty, 1970, the TRIPS Agreement, 1994.

Unit II: Nature of Copyright - Nature of Copyright - Subject matter of copyright- Registration Procedure, Term of protection, Ownership of copyright, Assignment and licence of copyright - Infringement, Remedies & Penalties – Related Rights - Distinction between related rights and copyrights.

Unit III: Patents - Elements of Patentability - Patents - Elements of Patentability: Novelty, Non Obviousness, Industrial Application - Non - Patentable Subject Matter - Registration Procedure, Rights and Duties of Patentee, Assignment and licence, Restoration of lapsed Patents, Surrender and Revocation of Patents, Infringement, Remedies & Penalties. Concept of Trademarks - Different kinds of marks (brand names, logos, signatures, symbols, well known marks, certification marks and service marks) - Non Registrable Trademarks - Registration of Trademark.

Unit IV: Traditional Knowledge - Introduction Meaning and Scope of traditional Knowledge – Interface between IP and traditional Knowledge – Need and Significance of protection - Documentation of Traditional Knowledge – Databases – Traditional Knowledge Digital Library “TKDL” – AYUSH Systems of Medicines – Biodiversity Register. Statutory Protection of Traditional knowledge in India Traditional Knowledge as Property – Nature of Property in genetic Resources and associated traditional Knowledge - Ownership in Traditional Knowledge.

Unit V: Patenting of Biotechnological and Pharmaceutical - Biotechnological and Pharmaceutical Introduction - Protection of Biological Inventions – Plant Patent Protection in India. Plant Varieties Protection of Plant Varieties and Farmer’s rights – GM Corps – Objectives of Plant Varieties Act – registration of Plant Varieties – Duration and effect of Registration – Infringement – Offences – Remedies – Biotech Patents in India - Research and Development in Biotechnology – NCE – Vaccine – Antibodies – GM.

Text Books

1. Nithyananda, K V. (2019). Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited.
2. Neeraj, P., &Khusdeep, D. (2014). Intellectual Property Rights. India, IN: PHI learning Private Limited

Reference Books

1. IPR, Biosafety and Bioethics. By Deepa Goel, Shomini Parashar.2013. Pearson.
2. Ahuja, V. K. , Law of Copyright and Neighbouring Rights, (2007), New Delhi, Lexis Nexis
3. Pradeep S. Mehta (ed.), Towards Functional Competition Policy for India, Academic Foundation, (2005)

External Elective for other major departments (Inter/multi disciplinary papers)

SEMESTER II A. Food Processing Technology

Unit I: Preservation and processing of food - Aim and objective, classification of foods by case of food spoilage- methods of food preservation – principles of food preservation- Asepsis – removal of microorganisms – maintenance of anaerobic conditions.

Unit II: Effect of Freezing and drying on Foods - Cold preservation – Freezing: requirements of refrigerated storage - controlled low temperature, air circulation and humidity, changes in food during refrigerated storage, progressive freezing, changes during freezing - Dehydration- Normal drying curve, effect of food properties on dehydration, change in food during drying, drying methods and equipments.

Unit III: Irradiation of food - Food Irradiation and Microwave Heating. Ionizing radiation and sources, unit of radiations, direct and indirect radiation effects, safety and wholesomeness of irradiated food. Microwave heating and application.

Unit IV: Packaging of foods - Properties of packaging material, factors determining the packaging requirements of various foods and brief description of packaging of frozen products, dried products, fats and oils and thermally processed foods.

Unit V: Material handling in food industry - Material handling. Elementary concept of material handling in food industry, equipment and functioning of belt conveyor, screw conveyor, bucket elevator and pneumatic conveyor. Thermal processing: Introduction, classification of Thermal Processes, Principles of thermal processing, Thermal resistance of microorganisms, Thermal Death Time, Lethality concept.

Text Books

1. Frazier, W. C. and D.C, Westhoff, Food Microbiology, 1988 (4th Edition), Tata McGraw Hill Publishing Company Ltd., New Delhi.
2. James, M.J., Modern Food Microbiology, 2007 (2nd Edition), CBS Publishers and Distributors, New Delhi.

Reference Books

1. Adams, M.R., and Moss, M.G., Food Microbiology, 2005 (1st Edition), New Age International (P) Ltd., New Delhi.
2. Banwant, G. J, Basic Food Microbiology, 2002 (2nd Edition) Chapman and Hall Inc., New York
3. Fellows, P., Food Processing Technology: Principles and Practice, (2nd Edition), Woodhead Publishing Limited and CRC Press LLC, England.

SEMESTER II B. Infectious Diseases and its Control

Unit I: Health; Disease – Definition, Infectious Vs Noninfectious; Pathogens – concept of pathogens, Microorganisms as pathogens; Transmission – Types, Factors; Primary infection Vs Secondary infection; Epidemic, Endemic and Pandemic.

Unit II: Occupational Diseases - examples, pathogens – source; **Airborne diseases** - examples, pathogens – source; **Vectorborne diseases** - examples, Vectors, pathogens.

Unit III: Foodborne diseases – examples, pathogens – source and contamination; Food hygiene; Foodborne infection, Food poisoning. **Waterborne diseases** – examples, pathogens – source and contamination; Water quality.

Unit IV: Zoonotic Diseases – examples (Rabies, Anthrax), pathogens – source. **Sexually Transmitted infections** - examples, pathogens involved.

Unit V: Treatment – Antibiotics, Antibacterial, Antifungal, Antiviral agents - **Prevention and Control of Diseases**; Immunization – Immunity, Immune system, Vaccines – types, examples, vaccination schedule; Personal hygiene, Healthy foods.

Text Books

1. Ananthanarayan R & Paniker C.K.J. (2013). Text Book of Microbiology, 9th edition, Universities Press, Hyderabad.
2. Monica Cheesbrough (2003). District Laboratory Practice in Tropical Countries. Part 1 & 2, Cambridge University Press.

Reference Books

1. Jawetz, Melnick, & Adelberg's. (2013). Medical Microbiology. 26th edition. McGraw-Hill, New York.
2. Murray. P.R., G.S, Kobayashi, M.A. Pfaller and K. S. Rosenthal, Medical Microbiology, 1993, (2nd Edition), Mosby St. Louis.
3. Brooks, G.F., Janet S. Butel, Stephen A, Jawetz, Melnick & Adlerberg's Medical Microbiology, 21st Edition, Prentice Hall International Inc. 1998.

SEMESTER II C. Microbial Ecology

Unit I: Microbial ecology: Basic concepts, Types, microbial habitats and factors affecting microbial populations; Microbial interactions - competition, commensalism, mutualism, synergism and Parasitism. Population Ecology: Characteristics of population, Population growth curves ((r and k selection) and population regulations.

Unit II: Microbial diversity in Normal environments: terrestrial (agricultural and desert soils), aquatic (fresh water and marine), atmospheric (stratosphere) and animal (cattle, termites).

Unit III: Microbial diversity in extreme environments: Oligotrophs, thermophiles, psychrophiles, barophiles, organic solvent and radiation tolerant, metallophiles.

Unit IV: Microbial Degradation: Bioaccumulation, Bio-magnification, Biodegradation of biopolymers (polyhydroxy alkanooates), Hydrocarbons (alkanes), Halogenated and sulfonated compounds. Pesticides degradation and recent advancement in treating pesticide residues.

Unit V: Marine Microbial Interactions: Microorganisms responsible for bioluminescence in marine environment; Microbial indicators of marine pollution and control; Biofouling, biocorrosion, biofilms, biodegradation and bioremediation in marine environment; use of genetically engineered microorganisms in biodegradation.

Text Books

1. Microbial Ecology By Atlas R.M., Bartha R., Benjamin Cummings Publishing Co, Redwood City, CA, 1993. 8. Norris et al., 1994, Handbook of Bioremediation, Lewis Publishers, London.
2. Jogdand, S.N.2010. Environmental Biotechnology (Industrial Pollution Management), Himalaya Publishing House, New Delhi.

Reference Books

1. Chatterji, A.K. 2005. Introduction to Environmental Biotechnology.
2. Environmental Microbiology by R. Mitchel (2nd edition), Wiley-Blackwell, 2009.
3. Environmental Microbiology by Raina Maier, Ian Pepper, & Charles Gerba, Academic Press, 2008.

SEMESTER – II Lab course - 2

Medical Bacteriology

Antibiotic sensitivity tests - disc method, MIC

Study of normal microflora of skin

Collection and processing of – sputum, urine, faeces, pus, blood - and isolation of pathogens

Acid fast staining

Metachromatic granular staining

Medical Mycology

Fungal slide culture

Germ tube testing

Industrial Microbiology

Production of Ethanol by Yeast.

Isolation of amylase producing microorganisms

Isolation of protease producing microorganisms

Isolation of lipase producing microorganisms

Production of wine from grape juice

Molecular Biology

Isolation of Genomic DNA and quantification

Isolation of Plasmid and quantification

Preparation of competent cells using CaCl₂.

Isolation of RNA and quantification.

Preparation of standard buffers and determination of pH of a solution

Quantitative estimation of protein by Biuret method

Quantitative estimation of protein by Lowry's method

Estimation of amino acids by ninhydrin method.

Absorption spectra- UV-Visible

Paper Chromatography of amino acids

SDS Gel electrophoresis

Agarose Gel electrophoresis

PCR technique
