ANNAMALAI UNIVERSITY
MASTER OF SCIENCE
M.Sc. Applied Microbiology
(With effect from 2021 – 2022)

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 Immuno technology	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								
5	**Core Elective**	**Paper-1**	3	3	**(to choose one out of 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	**(to choose one out of 3)** A. Microscopic Techniques B. Basics of Microbiology C. Molecular Biology	25	75	100
			30	**23**		**175**	**525**	**700**
SEMESTER II						***CIA***	***Uni. Exam***	***Total***
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								
11	**Core Elective**	**Paper-2**	3	3	**(to choose one out of 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	**(to choose one out of 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**

SEMESTER III						CIA	Uni. Exam	Total
15	Core	**Paper-7**	5	5	Medical Virology and Parasitology	25	75	100
16		**Paper-8**	5	4	Agricultural and Environmental Microbiology	25	75	100
17		**Paper-9**	4	4	Biotechnology	25	75	100
18		**Practical-3**	10	5	Lab Course – 3	50	150	200
Internal Elective for same major students								
19	**Core Elective**	**Paper-3**	3	3	**(to choose one out of 3)** A. Bioremediation B. Research Methodology C. Marine Microbiology	25	75	100
External Elective for other major departments (Inter/multi disciplinary papers)								
20	**Open Elective**	**Paper-3**	3	3	(Choose any one from other major departments)	25	75	100
21	****MOOC Courses**	**-**	-	-	(Choose any one from the enclosed list)	-	-	100
			30	**24**		**225**	**525**	**800**
SEMESTER IV						**CIA**	**Uni. Exam**	**Total**
22	**Core**	**Paper-10**	5	5	Recombinant DNA technology	25	75	100
23	**Core**	**Project Compulsory**	19	5	Project with *viva voce*	100 (75 Project +25 viva)		100
Internal Elective for same major students								
24	**Core Elective**	**Paper-4**	3	3	**(to choose one out of 3)** A. Diagnostic Microbiology B. Microbial Nanotechnology C. Bioethics	25	75	100
External Elective for other major departments (Inter/multi disciplinary papers)								
25	**Open Elective**	**Paper-4**	3	3	(Choose any one from other major departments)	25	75	100
			30	**16**		**75**	**325**	**400**
				90				**2800**

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

SEMESTER I

A. Microscopic Techniques
B. Basics of Microbiology
C. Molecular Biology

SEMESTER II

A. Food Processing Technology
B. Infectious Diseases and its Control
C. Microbial Ecology

SEMESTER III

A. Mushroom cultivation
B. Public Health Microbiology
C. Intellectual Property Rights

SEMESTER IV

A. Computational Biology
B. Biosafety
C. Algal Technology

*** 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 registred 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

****Mooc Courses**

Inclusion of the Massive Open Online Courses (MOOCs) with zero credits available on SWAYAM, NPTEL and other such portals approved by the University Authorities.

Massive Open Online Courses (MOOCs) with 2 credits available on SWAYAM, NPTEL

(Students have to complete anyone of the following courses equivalent to 2 credits)

(i) Biomedical nanotechnology – NPTEL (4 weeks)
(ii) Bioreactors – NPTEL (4 weeks)
(iii) Functional Genomics – NPTEL (4 weeks)
(iv) Computer Aided Drug Design – NPTEL (8 weeks)
(v) Ecology and Environment – NPTEL (8 weeks)
(vi) Health Research Fundamentals – NPTEL (8 weeks)
(vii) Introduction to Biostatistics – NPTEL (8 weeks)
(viii) Introduction to Research – NPTEL (8 weeks)
(ix) Introduction to Mechanobiology – NPTEL (8 weeks)
(x) Molecular Biology – CEC (8 weeks)
(xi) Metals in Biology – NPTEL (8 weeks)
(xii) Patent Drafting for Beginners – NPTEL (8 weeks)
(xiii) Tissue engineering – NPTEL (8 weeks)

ANNAMALAI UNIVERSITY

MASTER OF SCIENCE

M.Sc. Applied Microbiology

(With effect from 2021 – 2022)

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). Microbiology5th 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 Livingston, 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 DiegoVergani. 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 foodmmanufacture 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 (4lh 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. (4lh 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 Ouellellette, 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 Biotechology. 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) - Cartegana 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 - Histroy of Medical Bacteriaology. 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- histoplasmasis- Blastomycosis, coccidiomycosis, paracoccidiodomycosis- oppourtunistic systemic mycosis- aspergillosis, penicillosis - yeast of medial 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, Kobyashi, 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 – Chromatograghy, 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 (butyarate,

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, DNAstructure, 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 involvedin DNA replication –DNA polymerases, DNA ligase, primase, telomerase – for replication of linear endsVarious 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, aminoacyltRNA 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 - genetherapy, 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 flabelltus* (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, Kobyashi, 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 alkanoates), 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.Introductionto 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 $CaCl_2$.
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

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SEMESTER III
PAPER - 7

MEDICAL VIROLOGY AND PARASITOLOGY

Unit – 1 - INTRODUCTION TO VIROLOGY

Brief outline on discovery of Viruses - Nomenclature, Classification of Viruses - Distinctive properties of Viruses, Morphology & Structure. Detection of viruses and antigens in clinical specimens - Serological diagnosis of virus infections - Cultivation of viruses- Maintenance and handling of laboratory animals and requirements of virological laboratory.

Unit – 2 - VIRAL DISEASE AND ITS CLINICAL FEATURES

Viruses of importance to bacteria - Bacteriophages - Their structure, types - Uses in Microbiology. Epidemiology, Life cycle, Pathogenicity, diagnosis, prevention and treatment of DNA Viruses. Pox virus – Variola, Vaccinia, Herpes Simplex Virus – Varicella Zoaster virus, Adeno virus, Hepatitis virus – A, B & C, Cytomegalo virus, Epstein Barr virus– Papilloma virus. Epidemiology, life cycle, Pathogenicity, diagnosis, prevention and treatment of RNA Viruses. Picorna viruses – Polio virus, Orthomyxo virus – Influenza virus (H1NI1), Paramyxo viruses – Mumps virus, Measles virus, Rhabdo viruses - Rabies virus, Retro virus – HIV – Yellow fever virus, newly emerging viral disease –Ebola & Zika virus.

Unit – 3 - CLASSIFICATION AND PATHOGENESIS OF PARASITES

Introduction and classification of parasites - Laboratory diagnostic techniques in Parasitology - Epidemiology, Life cycle, Pathogenicity, diagnosis and treatment of Amoebiasis, Giardiasis, Balantidiosis, Trypanosomiasis, Malaria, Toxoplasmosis - Leishmaniasis. - Helminthic Infections - Taenia solium, T. Saginata, Echinococcus granulosus, Fasciola hepatica, Paragonimus westermani and Schistosomes - Ascaris lumbricoids, Ancylostoma duodenale, Trichuris triuchura - Enterobius vermicularis and Wuchereria bancrofti.

Unit – 4 - TREATMENT OF VIRAL DISEASES AND INFECTIONS

Viruses of importance to plants and soil - Viral vaccines, their preparation and their immunization schedules - Antiviral and Viral Vaccines - Conventional vaccines, killed and attenuated, modern vaccines—recombinant proteins, subunits, DNA vaccines. Modern approaches of virus control.

Unit – 5 - TREATMENT AND DIAGNOSTIC METHODS OF PARASITES

Control of Parasites - Biotechnological approaches to disease control and vaccine production. Prevention of parasitic infections - drugs and antibiotics - drug resistance. Detection and recovery of parasites from clinical specimens- Laboratory diagnostic techniques in Parasitology - Examination of Faeces, cultivation, Direct and concentration methods - Brief account on bioterrorism.

Text Books

1. Parija, S.C. (1996). Textbook of Medical Parasitology. Orient Longman.

2. Dimmock N.J., Primrose S.B. (1994). Introduction to Modern Virology 4th Edition. Blackwell Scientific Publications. Oxford.
3. Ananthanarayanan R. and Jayaram Panicker C.K. (1994). Text book of Microbiology. Orient Longman.

Reference Books

1. Chatterjee, K.D. Parasitology, M.D. 12th Edition. Chatter (1980) Joe media Publishers Culcutta.
2. Conrat HF, Kimball PC and Levy JA. (1988). Virology. II edition. Prentice Hall, Englewood Cliff, New Jersey.
3. Rajesh Karykarte and Ajit Damle (2003). Medical Parasitology, 3rd Edition. Books and Allied (P) Ltd, Kolkatha.
4. Morag C. and Timbury M.C. (1994). Medical Virology, 10th Edition. Churchil Livingston London.
5. Brooks, G.F., Janet S. Butel, Stephen A, Jawetz, Melnick & Adlerberg's Medical Microbiology, 21st Edition, Prentice Hall International Inc. 1998.

PAPER - 8

AGRICULTURAL AND ENVIRONMENTAL MICROBIOLOGY

COURSE OUTCOMES: Upon completion of this course the student should be able to:-

- Know the diverse group of soil microorganism
- Understand the nutrient sources and cycles
- Know about concept of disease, causal agent of plant disease identification methods and management of crop diseases
- To learn about microbial life in extreme environments
- To learn about microbial treatment of waste water

UNIT I: SOIL MICROBIOLOGY

Physical and chemical characteristics and classification of soils; soils microorganisms: Interactions between microorganism-symbiosis-mutalism-commensalism-competition-amensalism-synergism-parasitism-predation. Interaction of micros with plants Rhizospere ,Phyllosphere.

UNIT-II: BIOGEOCHEMICAL CYCLE AND BIO FERTILIZERS

MajorBiogeochemical cycle - carbon cycle - role of microbes in carbon cycle - trophic relationships - mobilization and immobilizations of carbon with rhizosphere. Nitrogen cycle - mechanism of biological nitrogen fixation - ammonification - nitrification - denitrificatioin and microorganisms involved in such processes. Phosphorous cycle and sulphur cycle.Bio fertilizer – symbiotic nitrogen fixation (Azolla ,BGA, Rhizobium , Frankia) Non –symbiotic(Azotobacter , Azospirillum) Phosphate solubilizers,VA Mycorrhizae- Isolation,mass production methods - applications methods of bio fertilizers - significance of bio fertilizers.

UNIT III: PLANT PATHOGENS

Plant pathogens and classification and plant diseases.Symptoms, Etiology, Epidemiology and management of the following plant diseases: Mosaic disease of tobacco; Bunchy top of banana; Leaf roll of potato; Bacterial blight of paddy; Angular leaf spot of cotton, Late blight of potato; Damping off of tobacco, Downy mildew ofbajra; Powdery mildew of cucurbits; Head smut of sorghum; Leaf rust of coffee; Blight of maize/sorghum; Leaf spot of paddy, Grassy shoot of sugar cane; Root knot of mulberry.

UNIT-IV: MICROBIOLGY OF AIR AND AQUATIC MICROBIOLOGY

Microbiology of air : distribution and source of air borne organisms aerosol – Droplet nuclei - Assessment of airquality , air sanitation – some important - Airbornediseases caused by Bactria, fungi , viruses their symptoms and preventive measures , aquatic microbiology : ecosystems – fresh water (ponds ,lakes, streams , marine , estuaries , mangroves , deep sea) water zonation – eutrophication , water borne diseases.

UNIT-V:MICROBIAL TREATMENT OF WASTE WATER

Potable water; Assessment of microbiological quality of water. Waste treatment;Types of wastes, characterization of solid and liquid waste – waste treatment and useful by products , Solid waste treatment - saccarification– gasification – composting. Liquid waste treatment – aerobic and anaerobic methods.Organic matter decomposition

Text Books

1. Atlas, R.M. AND Bartha R. 1992. Microbial ecology; Fundamental and applications. Second Edition Redwood city. CA.Benjamin/Cummings.
2. Joseph C. Daniel (1999) Environmental Aspects of Microbiology, Bright Sun publications , Chennai.
3. Ramanathan, and Muthukaruppan SM (2005) Environmental Microbiology. Om SakthiPathipagam, Annamalai Nagar.

Reference Books

1. Dirk J, Elas V, Trevors JT, Wellington, EMH (1997) Modern Soil Microbiology, Marcel Dekker INC, New York.
2. Grant WD, Long PL. (1981) Environmental Microbiology. Blackie Glasgow and London.
3. Fletcher, M. and Gray, T.R.G. (1987). Ecology of Microbial communities. Cambridge University Press, Cambridge, UK.
4. Alexander M. (1977) Introduction to soil microbiology. John Wiley & Sons, Inc., New York.
5. Marshall, K.C. (1985) Advances in Microbial Ecology, Vol.8, Plenum Press, U.K.

PAPER - 9

BIOTECHNOLOGY

Course Objectives

1. To acquire knowledge about the range of approaches in plant genetic engineering and production of transgenic plants and its applications.
2. To get insight about gene transfer technology in animals and applications of Animal biotechnology.
3. To deliver extensive knowledge on Medical Biotechnology.
4. To impart knowledge about bioremediation and its significance in the Environmental biotechnology.
5. To offer comprehensive information and insights in pharmaceutical biotechnology and drug designing.
6. To increase awareness of professional, ethical and social responsibilities with relationship to biotechnology thereby increasing the opportunities to pursue higher studies in foreign countries.

Unit-1: Plant Biotechnology

Plant Genetic Engineering and Production of Transgenic Plants - Transformation of plant cells; Modes of gene delivery in plants - Particle bombardment, electroporation, microinjection, Agrobacterium mediated gene transfer; Plant Tissue Culture; Screening and selection of transformants - PCR and hybridization methods; Potential applications of plant genetic engineering for crop improvement - insect-pest resistance, abiotic stress resistance, herbicide resistance, storage protein quality, increasing shelf-life, oil quality; Bt cotton, Golden rice.

Unit-2: Animal Biotechnology

Gene transfer technology in animals: Viral and non-viral methods - Retroviral, Microinjection, Embryonic stem cells methods; IVF technology for livestock improvement; Animal tissue culture; Transgenic animals -Transgenic cattle, Transgenic sheep and goats, Transgenic fish; Applications of animal Biotechnology - Improvement of biomass, disease resistance, recombinant vaccines for poultry.

Unit-3: Medical Biotechnology

Gene Therapy - Approaches for gene therapy, Ex-Vivo vectors - Human Artificial chromosome and Bone marrow cells – Therapy for Adenosine deaminase (ADA); In vivo – viral and non-viral systems; Gene therapy for AIDS and Cancer; DNA in Disease diagnosis – Infectious and Genetic diseases; Recombinant vaccines and their types - subunit vaccine, attenuated recombinant vaccines, vector recombinant vaccines; Stem cell therapy.

Unit-4: Environmental Biotechnology

Bioaccumulation; Biomagnification; Biodegradation of hydrocarbons, pesticides, herbicides and Xenobiotic compounds; Bioaugmentation; Bioremediation and its types - in situ & ex-situ bioremediation;; Bioremediation of contaminated soil and ground water; Genetically Engineered Microorganisms (GEMs) in bioremediation; Microbial Enhanced Oil Recovery (MEOR); Bioleaching – Copper and Uranium leaching; Biosurfactants, Biofuels and Bioplastics.

Unit-5: Pharmaceutical Biotechnology

Drug Designing and Development - Current Trends in Drug Development, Drug designing- Rational, combinatorial and High Throughput screening. Clinical trials; Drug Delivery Systems – Types, Nanoparticles used in drug delivery system; Pharmaceutical products produced by mammalian cells – tissue plasminogen activator, interferons, erythropoietin, blood clotting factors. Clinical Research - Past, Present and Future.

Text Books

1. Dubey R.C (2005). A Text of Biotechnology. Multicolour Illustrative edition, S.Chand and Company Ltd., New Delhi.
2. Bernad R Glick and Pasternak, J.J (2003). Molecular Biotechnology - Principles and Applications of Recombinant DNA.3rd edition, ASM Press, Washington, D.C.
3. Satyanarayana U (2005). Biotechnology. 1st edition, Books and Allied (P) Ltd., Kolkata.

Reference Books

1. Singh. B.D., Plant Biotechnology. Kalyani Publishers, 3rd Edition, 2015.
2. M.M. Ranga., Animal Biotechnology, Agrobios, India, 2000.
3. K Sambamurthy and Ashutosh Kar., Pharmaceutical Biotechnology, New age International Publishers, New Delhi, 2006.
4. Judit Pongracz and Mary Keen, Medical Biotechnology 1st Edition, Elsevier publications, 2008.
5. Geetha Bali et al eds., Environmental Biotechnology, ApS Pub., 2001.

CORE ELECTIVE

PAPER -3

(to choose one out of 3)

A. BIOREMEDIATION

Unit I: Overview of Bioremediation - Definition of Bioremediation - Types of pollutants - organic, inorganic in soil, water and air - Remediation by bacteria, fungi, microalgae and green plants.

Unit II: Natural attenuation - Bioaccumulation and biomagnification processes - microbial remediation by natural attenuation - biostimulation - bioaugmentation.

Unit III: Application of genetically engineered microbes. - Application of immobilized microbes in soil decontamination - use of genetically engineered microorganism and bioremediation.

Unit IV: Phytoremediation - Biodegradation of organic compounds - humification and polymerization reaction - bio- transformation of metal and metal compounds - phytoremediation use of microalgae, green plants to remove pollutants.

Unit V: Phytoextraction – continuous phyto-extraction - phyto-degradation - rhizofiltration - phyto-stabilisation - phyto- volatisation of metals - phyto-remediation of organic; Bioavailability and uptake; Biotransformation and compartmentalisation.

Text Books

1. Bioremediation: Principles and Applications. Editors: Don L. Crawford, Ronald L. Crawford. 1996. Cambridge.
2. Approaches in Bioremediation: The New Era of Environmental Microbiology and Nanobiotechnology. Edited by Ram Prasad, Elisabet Aranda. 2018. Springer.

Reference Books

1. Wainwright, M. 1999. An introduction to environmental biotechnology.Boston, Mass. Klumer Academic Publishers.
2. Environmental Pollutants and Their Bioremediation Approaches. 2017. Ed. by R.N. Bharagava. CRC Press.
3. Bioremediation: Applied Microbial Solutions for Real–World Environmental Cleanup. Ed. by Ronald M. Atlas, Terry Hazen, James Philp. 2005. American Society for Microbiology.

CORE ELECTIVE

PAPER -3

B. RESEARCH METHODOLOGY

Unit I: Research: Definition – Literature Collection – Literature Citation – Experimental designs - Major search engines - Major Websites, book and scientific information - Identification, Selection and formulation of research problem – Research questions – Research Ethics

Unit II: Research Report: Components of a Research Report – Authors and Addresses – Abstract – Synopsis – Key words – Introduction – Materials and Methods – Results – Discussion – Acknowledgements – Summary and Conclusions – Appendices – References - Title – Tables – Figures – Formatting and Typing- Plagiarism.

Unit III: Collection of data: Primary data and Secondary data – meaning – Data collection methods – Relevances – Limitations and cautions. Measures of central tendency: Arithmetic Mean, Median, Mode, Geometric Mean and Harmonic Mean. Measures of Dispersion: Range, Quartile Deviation, Mean Deviation, Standard Deviation and Coefficient of Variation.

Unit IV: Correlation analysis: Karl Pearson's, Spearman's rank and Concurrent deviation methods. Regression Analysis: Simple regression equations.

Unit V: Sampling theory: types of sampling – Sampling and non sampling error and Advantages and disadvantages in sampling – probability and non-probability sampling methods- Concept of Sampling distributions – Standard Error.

Text Books

1. Statistical Methods. (32nd edition - 2004), Gupta. S. P., Sultan Chand & Sons, New Delhi.
2. Dr. N. Gurumani, Research Methodology: For Biological Sciences, 2006, MJP Publishers.
3. Dr. N. Gurumani, An Introduction to Biostatistics, 2006, 2nd Edition, MJP Publishers.

Reference Books

1. Singh, Y. K. (2006). Fundamental of Research Methodology and Statistics. New Delhi. New International (P) Limited, Publishers
2. Y. K. Singh and R. B. Bajpai, Research Methodology Data Presentation, 2008, APH Publishing Corporation, New Delhi.
3. Anthony, M., Graziano, A.M. and Raulin, M.L., 2009. Research Methods: A Process of Inquiry, Allyn and Bacon.

CORE ELECTIVE

PAPER -3

C. MARINE MICROBIOLOGY

Unit I: Marine Microbial Habitats - Marine environment– shallow and deep sea, coastal, mangroves and coral environments - properties of seawater , chemical and physical factors of marine environment; Diversity of microorganisms in marine environment - Archaea, bacteria, actinobacteria, cyanobacteria, algae, fungi, viruses and protozoa.

Unit II: Marine Extremophiles - Marine extremophiles - Survival at extreme environments – starvation – adaptive mechanisms in thermophilic, alkalophilic, osmophilic and barophilic, psychrophilic microorganisms – hyperthermophiles, halophiles and their importance; Significance of marine microflora - Microbial endosymbionts – epiphytes, coral-microbial association, sponge-microbial association.

Unit III: Cultivation of Marine Microbes and Nutrient cycling - Methods of studying marine microorganisms - sample collection, isolation and identification; Preservation methods of marine microbes; Nutrient cycling in Marine Environment - Role of microorganisms in carbon, nitrogen, phosphorous and sulphur cycles in the marine environment.

Unit IV: Marine Pollution and Bioremediation - Pollution in marine environment; Pathogenic microorganisms, distribution, indicator organisms, prevention and control of water pollution, quality standards; Xenobiotics, heavy metals and crude oil; Native microbial consortia and Genetically Engineered Microbes in bioremediation of polluted marine sites - Biofouling – Causes and their control.

Unit V: Microbial Products from Sea - Production and applications of marine microbial products – Carrageenan, agar-agar, sea weed fertilizers, β carotene, enzyme, antibiotics, antitumour agents, biosurfactants and pigments; Preservation methods of sea foods; Quality control and regulations for microbial quality of fishes, shellfish and Marine living resources used for food.

Text Books

1. Colin B. Munn. Marine microbiology: Ecology and Applications. 3rd Edition. 2020. Taylor & Francis Inc.
2. B. Austin. Marine Microbiology. Cambridge University Press. 1988.

Reference Books

1. Microbial Ecology of the Oceans, Third Edition. Josep M. Gasol and David L. Kirchman (editors). John Wiley & Sons, USA. 2018.
2. The Living Ocean: Marine Microbiology. E. J. Ferguson Wood. Springer Science & Business Media. 2012.
3. Se-Kwon Kim (Editor). Marine Microbiology: Bioactive Compounds and Biotechnological Applications. Wiley-VCH Verlag GmbH. 2013.

OPEN ELECTIVE

PAPER -3

(to choose one out of 3)

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 flabelltus* (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.

OPEN ELECTIVE

PAPER -3

B. PUBLIC HEALTH MICROBIOLOGY

Unit I: Overview on common water bore diseases, Microbiology of causative agents, epidemiology, pathogenesis, laboratory diagnosis, prevention and control of hepatitis, cholera, typhoid, amoebiasis, giardiasis, poliomyelitis, diarrhoea (bacterial and viral).

Unit II: Overview on common air-borne diseases, Microbiology of causative agents, epidemiology, pathogenesis, laboratory diagnosis, prevention and control of pneumonia, diphtheria, tuberculosis, anthrax, influenza, measles, Coronoviruses – SARS & MERS.

Unit III: Concept on food borne infections and food intoxication, Microbiology of causative microorganisms, epidemiology, pathogenesis, laboratory diagnosis, prevention and control of Staphylococcal, Clostridial food poisoning, salmonellosis, shigellosis and travellers' diarrhoea.

Unit IV: Overview on common vector-borne diseases and their vectors, Microbiology of causative organisms, epidemiology, pathogenesis, laboratory diagnosis and prevention and control of malaria, filariasis, Dengueand swine flu .

Unit V: Concept on common nosocomial infections, Disinfection procedures of hospital environment, equipments and materials, methods of disposal of infective hospital waste and laboratory materials, monitoring of sanitation in hospital environment.

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. Subhash Chandra Parija (2013). Text book of Medical Parasitology. 4th edition, All India Publishers and Distributors (Medical Books Publishers), New Delhi.
3. ChatterjeeK.D (2016). Parasitology, Protozoology& Helminthology. 13th edition. Joe media Publishers. Calcutta.

OPEN ELECTIVE

PAPER -3

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)

SEMESTER – III

Lab course - 3

Medical Parasitology
Iodine preparation of stool sample for parasites

Medical Virology
Isolation of bacteriophages from sewage
Estimation of virus yields - plaque assay
Inoculation in embryonated eggs
Haemagglutination test
Hemagglutination inhibition assay
One step growth curve of bacteriophage by Burst size determination
ELISA technique

Agricultural Microbiology
Isolation and Identification of Symbiotic Nitrogen-fixing bacteria from root nodules
Laboratory scale production of biofertilizers
Isolation of phosphate solubilizing bacteria
Demonstration of Rhizosphere effect
Staining and observation of plant pathogenic fungi

Environmental Microbiology
Assessment of water quality by MPN Test
Enumeration of bacteria in water
Enumeration of bacteria and fungi in soil

SEMESTER IV

PAPER – 10

RECOMBINANT DNA TECHNOLOGY

UNIT I - History of r-DNA technology

Restriction enzymes and their role in r-DNA technology-Restriction-modification system methylase,ligase, adaptors, linkers, homopolymer tailing, E.coli-Types of restriction enzymes -Plasmid vectors as cloning vehicles-Vectors for protein over expression, protein secretion and controlled expression-Bacteriophages as cloning vehicles-λ mediated vectors-M13 phage and its use, Cosmids, Phagemids, plasmids, BACS.

Unit – II Techniques and enzymes in genetic recombination

Core techniques and essential enzymes used in recombination: restriction endonucleases,type I, II, III, recognition sequences, properties, nomenclature, classification of type II endonucleases, their activity. DNAligase: Properties and specificity, S1 nuclease, BAL 31 nuclease, DNA polymerase, polynucleotide kinase, phosphatase, reverse transcriptase its activity and mode of action. Chemical synthesis of DNA. Restriction digestion, ligation and transformation.

UNIT-III Gene Cloning

Purpose –Genomic Library construction-Polymerase chain Reaction (PCR)-Cloning into gram negative, gram positive bacteria and Yeast-Screening of recombinants-α complementation and blue-white selection - Construction of cDNA and genomic DNA libraries: Vectors used in the construction of cDNA versus genomic DNA libraries. Steps and enzymes involved in the construction of cDNA versus genomic DNA libraries.DNA sequencing-DNA and RNA hybridization-Southern and Northern blotting-DNA sequencing-Sangers method-Basics of pyrosequencing, next generation sequencing strategies-western blotting for proteins-Semi-quantitative and Real time PCR to quantify gene expression-Yeast two hybrid system

Unit – IV PCR methods and Applications

Polymerase Chain Reaction: Concept of PCR and various thermophilic enzymes used in PCR. Gradient PCR versus Touchdown PCR. Designing primers. Cloning PCR products. Differential Display PCR, RAPD fingerprinting of micro-organisms, Overlap PCR, Rolling Circle Amplification Technology.

UNIT-V Protein engineering and Pharmaceutical products

Protein engineering and proteome analysis: Proteome analysis by 2D gel electrophoresis coupled to mass spectrometric analysis. Protein arrays and their applications. Pharmaceutical products of DNA technology: Human protein replacements – insulin, hGH and Factor VIII. Human therapies – TPA, interferon, antisense molecules. Vaccines – Hepatitis B, AIDS, and DNA vaccines. Good hygienic procedure (GHP), Good manufacturing procedure (GMP), Good laboratory procedure (GLP) and ISO-9ooo- HACCP. Transgenics and animal cloning: Creating transgenic animals and plants. Animal cloning.

Text Books

1. Principles of Gene Manipulation and Genomics-S.B.Primrose and R.M.Twyman, 2006.John Wiley & Sons Ltd.
2. Molecular Biotechnology: Principles and Applications of Recombinant DNA. 2 nd Edition. 1998 by Bernard R. Glick and Jack J. Pastemak, ASM Publications.
3. Genetic Engineering and Introduction to Gene Analysis and Exploitation in Eukaryotes by S.M. Kingsman and A.J. Kingsman, Blackwell Scientific Publications, Oxford 1998.

Reference Books

1. From Genes to Genomes: Concepts and Applications of DNA Technology, Second Edition-Jeremy.W.Dale and Malcolm Von Schantz, 2007. John Wiley & Sons Ltd.
2. Molecular Biology of the Gene by James Watson, Tania Baker, Stephen Bell, Alexander Gann, Michael Levine & Richard Losick , 6th Edition; CSHL Press; 2007
3. PCR Technology - Principles and Applications for DNA Amplification by Henry A. Erlich (Ed.) Stockton Press. 1989.
4. DNA Cloning: A Practical Approach by D.M. Glower nd B.D. Hames, IRL Press,Oxford. 1995.
5. Molecular Cloning: A laboratory manual by Joseph Sambrook & David Russell, 3rd edition; CSHL Press; 2001.

CORE ELECTIVE

PAPER - 4

A. DIAGNOSTIC MICROBIOLOGY

Unit I: Purpose and philosophy of diagnostic microbiology – Organization of clinical microbiology laboratory - Laboratory safety: General safety considerations – biohazards and practices specific to microbiology – classification of biological agents on the basis of hazards.

Unit II: Collection of clinical specimens (oral cavity, throat, skin, blood, CSF, urine and faeces) associated with bacterial, viral, fungal and protozoan diseases for diagnosis - methods of transport and storage; rejection of specimen; safe disposal of specimens.

Unit III: Examination and processing of clinical specimens - staining - Gram stain, Ziehl – Neelson staining for tuberculosis, - LPCB for fungal identification – Giemsa stained thin blood film for malaria, Wet mount and Iodine method for parasites – Culture based techniques - isolation and identification of bacterial and fungal pathogens, Automated system for identification.

Unit IV: Serological Methods – Agglutination based methods: WIDAL, immunofluorescence – Automated methods: ELISA (commercial kits for diagnosis); Immunodetection of microbial toxins; Nucleic acid based methods - PCR.

Unit V: Importance and determination of antimicrobial resistance/sensitivity of bacterial and fungal pathogens - Determination using disc diffusion method, Minimal inhibitory concentration (MIC), E test; Antimycotic susceptibility testing; Reporting of results (CLSI, EUCAST); Computerization - Quality assurance.

Text Books

1. Tille P. (2013). Bailey's and Scott's Diagnostic Microbiology, 13th edition, Mosby Publishers, United States.
2. Collee J.G, Fraser, A.G, Marmion B.P and Simmons A (2007). Mackie and Mccartney Practical Medical Microbiology, 14th edition, Elsevier Publishers. London.

Reference Books

1. Connie Mahon and Donald Lehman (2018). Text book of Diagnostic Microbiology. 6th edition, Elsevier, United States.
2. James G Cappuccino and Natalie Sherman (2004). Microbiology: A laboratory manual. 6th edition, Published by Pearson Education, United States.

3. Brooks G.F, Carroll K.C, Butel J .S, Morse S.A and Mietzner T. A (2013). Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication.

CORE ELECTIVE

PAPER - 4

B. MICROBIAL NANOTECHNOLOGY

Unit- I - Introduction to nanobiotechnology History – bionanotechnology – concept and future prospects – application in Biological Sciences. Terminologies – nanotechnology, bionanotechnology, nanobiomaterials, biocompatibility, nanomedicine, nanowires, quantum Dots, nanocomposite, nanoparticles, nanosensors. Biotechnology to bionanotechnology, natural bionanomachines. Present status of nanobiotechnology.

Unit- II - Types of nanoparticle synthesis Molecular nanobiotechnology – nanomachines – collagen. Applications of nanoparticles – cancer nanotherapy – manipulation of cell and biomolecules. Cytoskeleton and cell organelles. Physical, chemical and biological synthesis of nanoparticles. Microbial synthesis of nanoparticles – mechanism of synthesis.

Unit III - Nanoparticles Types and their characterization techniques Nanoparticles – types, functions – Silver, Gold and Titanium. Physical and chemical properties of nanoparticles. Characterization of nanoparticles – UVVis spectroscopy, particle size analyzer, Electron Microscopy – HRTEM, SEM, AFM, EDS, XRD. Other tools and techniques required for bionanotechnology: rDNA technology, site directed mutagenesis, fusion proteins, X- Ray crystallography, NMR. Bioinformatics: molecular modeling, docking, computer assisted molecular design.

Unit IV - Nanoscale applications in biology and medicine: Nanotechnology in biology and medicine - Micro- and nano- fluidics - Scanning probe microscopy in biology and medicine – Self assembly of biological molecules. Drug delivery – protein mediated and nanoparticle mediated. Hybridconjugates of gold nanoparticles – DNA oligomers – use of DNA molecules in nanomechanics and Computing. Nanoparticles as carrier for genetic material. Nanomedicines, Antibacterial activities of nanoparticles. Toxicology in nanoparticles

Unit V - Environmental effects of nanoparticles: Health and safety implications from nanoparticles: Health issues – Environmental issues – Need for regulation – Societal implications: Possible military applications – Potential benefits and risks for developing countries – Intellectual property issues – Criticism of Nanotechnology – Studies on the implications of Nanotechnology.

Text Books

1. Elisabeth Papazoglou and Aravind Parthasarathy. Bionanotechnology. Morgan and Claypool Publishers. 2007.
2. David Goodsell S. Bionanotechnology, Lessons from Nature, Wiley-Liss, Inc. 2004.

Reference Books

1. Claudio Nicolini. Nanobiotechnology and Nanobiosciences Pan Stanford Publishing Pte. Ltd. 2009.
2. David E Reisner and Joseph D Bronzino. Bionanotechnology: Global Prospects. CRC Press. 2008.
3. Ehud Gazit. Plenty of Room for Biology at the Bottom: An Introduction to Bionanotechnology. Imperial College Press. 2006.

CORE ELECTIVE

PAPER - 4

C. BIOETHICS

Unit I: Ethics – definition – Bioethics – definition - The birth of the concept of 'bioethics' - History of Bioethics as a Discipline - Bioethics as bridge between facts and values - Bioethics versus medical ethics - Health and disease as values.

Unit II: Principles of bioethics - Health care decisions include facts and values, Universal Declaration on Bioethics and Human Rights - Conflicts between bioethical principles - Limits to the autonomy of patients - Limits of justice and resource allocation

Unit III: Ethics committees – Need, Types,Composition, Function - Human dignity and human rights - Benefit and harm – Definitions, comparing harms and benefits; Autonomy and individual responsibility, health care provider-patient relationship; 'informed consent'.

Unit IV: Respect for human vulnerability and personal integrity; respecting privacy and confidentiality; Equality, justice and equity; discrimination and stigmatization - Non-discrimination and non-stigmatization; Respect for cultural diversity and pluralism; Solidarity and cooperation in healthcare and society.

Unit V: Social responsibility and health; Responsibilities for governments and various sectors of society; Access to essential drugs and health services; health as a fundamental human right; HIV / AIDS as an example in ethical context; Sharing of benefits; Protecting future generations; Protection of the environment, the biosphere and biodiversity.

Text Books

1. Bioethics for Scientists. John A. Bryant, Linda Baggott la Velle, John F. Searle. Wiley. 2002.
2. Advisory Expert Committee for the Teaching of Ethics. Bioethics Core Curriculum. UNESCO 2016.

Reference Books

1. Deni Elliot. Ethical Challenges: Building an Ethics Toolkit Authorhouse: 2008.
2. Thomas A. Shannon and Nicholas J. Kockler, An Introduction to Bioethics. 4th Edition. Paulist Press, 2009.
3. Robert J. Spitzer, S.J., Ph.D. Ten Universal Principles: A Brief Philosophy of the Life Issues. Ignatius Press, 2011.
Tom L Beauchamp. Jerffry Khan,LeRoy Walters, Anna C Mastroanni.(2013) Contemporary issues in Bioethics.

OPEN ELECTIVE
PAPER - 4
(to choose one out of 3)

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 Ouellellette, 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.

OPEN ELECTIVE
PAPER - 4

B. 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) - Cartegana 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.

OPEN ELECTIVE

PAPER - 4

C. 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 Biotechology. Daya Publishing House.

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