6. Structure of M.Sc. Immunology & Microbiology program

COURSES OF STUDY AND SCHEME OF ASSESSMENT - M.Sc. Immunology and Microbiology

(MINIMUM CREDITS TO BE EARNED: 90)

Code No.	Course	Hours/week			Credits	Maximum Marks		
		Lecture	Tutorial	Practical		CA	SEE	Total
SEMESTER 1								
CORE 1	Cell Culture and Fermentation Technology	4	0	0	4	40	60	100
CORE 2	Immunology	4	0	0	4	40	60	100
CORE 3	General Microbiology	3	0	2	4	40	60	100
CORE	Practical Immunology and Systemic Bacteriology	0	0	4	2	40	60	100
DSE	Medical Bacteriology and Virology	4	0	0	4	40	60	100
DSE	Industrial Microbiology	4	0	0	4	40	60	100
SEC	Soft Skill 1	2	0	0	2	40	60	100
	Total	21	0	6	24	280	420	700
SEMESTER 2								
CORE 4	Microbial Genetics and Molecular Biology	4	0	0	4	40	60	100
CORE 5	Molecular Immunology and Immunogenetics	4	0	0	4	40	60	100
CORE 6	Medical Mycology and Parasitology	4	0	0	4	40	60	100
CORE 7	Practical Molecular Biology	0	0	4	2	40	60	100
CORE 8	Practical Immunotechnology	0	0	4	2	40	60	100
DSE	Immunotechnology	4	0	0	4	40	60	100
SI	Internship	0	0	4	2	40	60	100
SEC	Soft Skill 2	2	0	0	2	40	60	100
	Total	18	0	12	24	320	480	800
SEMESTER 3								
CORE 9	Clinical Immunology and Vaccinology	4	0	0	4	40	60	100
CORE 10	Soil Microbiology	4	0	0	4	40	60	100
CORE 11	Environmental Microbiology	4	0	0	4	40	60	100
CORE 12	Practical in Environmental Microbiology and Vaccine preparation	0	0	4	2	40	60	100
DSE	Biofertilizers Technology	4	0	0	4	40	60	100
DSE	Food Microbiology	4	0	0	4	40	60	100
SEC	Soft Skill 3	2	0	0	2	40	60	100
	Total	22		4	24	280	420	700
SEMESTER 4								
CORE 13	rDNA Technology and Nanomicrobiology	4	0	0	4	40	60	100
GE	Pharmaceutical Microbiology	4	0	0	4	40	60	100
CORE	Project Work	0	0	20	10	40	60	100
	Total	8	0	20	18	120	180	300

DSE - Disciple Specific Elective Course; GE - Generic Elective Course; CA - Continuous Assessment; SEE – Semester End Examination

Marks for Internal and End Semester Examinations

Sl. No	Category	Theory	Practical
1	Continuous Internal Assessment	40	40
2	End Semester Examination	60	60

Procedure for Awarding Internal Marks:

Course	Continuous Internal Assessment Components	Marks
Theory	Class Test 1	5
	Class Test 2	5
	Assignment / Seminar	5
	Assessment by Faculty	5
	Aptitude of the student	5
	Model Exam	10
	Attendance	5
	Total	**40**
Practical	Assessment by Faculty	5
	Aptitude of the student	5
	Model Practical Exam	10
	Practical Observation	5
	Record work	10
	Attendance	5
	Total	**40**

Awarding Marks for Attendance:

Percentage of Attendance	**Marks**
Below 65	00
65- 74	03
75- 90	04
91- 100	05

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DETAILS OF COURSES

List of Core Courses

CC1: Cell Culture and Fermentation Technology
CC2: Immunology
CC3: General Microbiology
CC3P: Practical - Microbiology
CC4: Practical - Immunology and Systemic Bacteriology
CC5: Microbial Genetics and Molecular Biology
CC6: Molecular Immunology and Immunogenetics
CC7: Medical Mycology and Parasitology
CC8: Practical - Molecular Biology
CC9: Practical - Immunotechnology
CC10: Clinical Immunology and Vaccinology
CC11: Soil Microbiology
CC12: Environmental Microbiology
CC13: Practical - Environmental Microbiology and Vaccine preparation
CC14: rDNA Technology and Nanomicrobiology

List of Discipline Specific Electives (Any 6 papers)

DSE1: Immunotechnology
DSE2: Medical Bacteriology and Virology
DSE3: Industrial Microbiology
DSE4: Biofertilizers Technology
DSE5: Food Microbiology
DSE6: Microbial Biochemistry
DSE7: Research methodology
DSE8: Biostatistics
DSE9: Medical Microbiology
DSE10: Industrial and Pharmaceutical Microbiology
DSE11: Cloning Strategies and Nanomicrobiology
DSE12: Medical Parasitology
DSE13: Animal Cell Culture
DSE14: Good Manufacturing Practices

List of Generic Electives (Any 3 papers)

GE 1: Pharmaceutical Microbiology
GE 2: Introduction and Scope of Microbiology
GE 3: Bacteriology and Virology
GE 4: Microbial Metabolism
GE 5: Industrial and Food Microbiology

GE 6: Microbes in Environment

GE 7: Medical Microbiology and Immunology

GE 8: Genetic Engineering and Biotechnology

Course learning outcomes and contents of the courses
CORE COURSES (CC)

21CMIM11 CC1: Cell Culture and Fermentation Technology 4 0 0 4

Course Objective: The candidate will gain knowledge about fermentation types and kinetics, fermenters; media formulation and characteristics; industrial type/ scale sterilization, GLISP; animal culture; animal cell culture systems and applications.

UNIT I FERMENTATION 12

General consideration of fermentation process. Screening and selection of industrially important cultures and Inoculum development. Types of fermentation-submerged, solid state, batch, fed batch, continuous, single, dual, multiple. growth kinetics of batch and continuous culture-chemostat and turbidostat.

UNIT II MEDIA FORMULATION 12

Media formulation, medium optimization, aeration and agitation, Factors affecting oxygen transfer – Determination of K_{La} Values-Newtonian and non Newtonian fluids. Physical and chemical environmental sensors, fermentation control systems-manual and automatic.

UNIT III DESIGN OF FERMENTOR 12

Basic objective of fermenter design, aseptic operation & containment, body construction, agitator and sparger design, baffles, stirrer glands and bearings. Process parameters and measurement techniques: measurement of temperature, pressure and pH, DO, foam etc.; flow rate of liquid and gases; Types of fermentor - Bubble column, airlift reactor, packed bed, fluidized bed, Photobioreactor, Control of fermentation process – offline/inline measurements - PID. Validation of Fermentor.

UNIT IV STERILIZATION 12

Sterilization-Types of sterilization, batch and continuous, Insitu and exsitu. Sterilisation of media, bioreactor and accessories, fed additives. Sterilization kinetics – del factor, TDT, 12 D concepts, asepsis and containment – GMP, GILSP, HACCP, IPR, TRIPS, GATT.

UNIT V ANIMAL CELL CULTURE 12

Basic techniques of mammalian cell culture in vitro; disaggregation of tissue and primary culture, maintenance of cell culture; cell separation. Cell synchronization; Cell cloning and micromanipulation; Cell transformation; Application of animal cell culture; Scaling-up of animal

cell culture. Stem cell cultures, embryonic stem cells and their applications; Cell culture-based vaccines.

Total: 60 Lecture Hours

Course Outcome

At the end of the course, learners will be able to:

CO1: Write about the types of fermentation process and its kinetics.

CO2: Substitute the strategy involved in the media formulation and fermentation process control

CO3: Design the types of fermentor and its process parameters.

CO4: Evaluate the process of sterilization, screening, scaleup, and downstream processing

CO5: Analyze stem cell cultures, E S cell application, vaccines and somatic cell genetics

TEXTBOOK:

1. Mukhopadhyay S., Process Biotechnology Fundamentals, Ed.2; Viva Books Pvt. Ltd. 2004.

REFERENCE BOOKS:

1. Glyn Stacey, Medicines from Animal Cell Culture; John Wiley and Sons Ltd. 2007.
2. Ralf Portner, Animal Cell Biotechnology: Methods and Protocols (Methods in Biotechnology); Humana Press Inc., U.S. 2007.
3. Joanna Picot, Human Cell Culture Protocols (Methods in Molecular Medicine); Humana Press Inc., U.S. 2004.
4. Jan-Thorsten Schantz and Kee Woei Ng., A Manual for Primary Human Cell Culture ;World Scientific Publication. 2004.
5. Sadettin Ozturk and Wei-Shou Hu, Cell Culture – Technology for Pharmaceutical and Cell – Based Therapies (Biotechnology and Bioprocessing); Taylor and Francis. 2004.
6. Butler, M., Animal Cell Culture and Technology: The Basics; Garland Science. 2003.
7. Davis. J.M., Basic Cell Culture: A Practical Approach ; Oxford University Press. 2002.
8. John R.W. Masters, Animal Cell Culture: A Practical Approach, Ed.3; Oxford University Press. 2000.
9. Stanbury PF, Whitaker A, Hall SJ, Principles of Fermentation Technology; Pergamon Press. 1995.
10. Anton Moser, Bioprocess Technology – Kinetics and Reaction; Springer Verlag, New York. 1998.
11. El-Mansi, EMT., Fermentation Microbiology and Biotechnology; Taylor and Francis Publishers. 2005.

12. Balasubramanian, D., Bryce CFA, Dharmalingam, K., Green J., Kunthala Jayaraman., concepts of Biotechnology; University Press. 2004.

21CMIM12 CC2: Immunology 4 0 0 4

Course Objective: The candidate will acquire knowledge of the immune system; appreciate the role of the immune system in health and disease; and explain the types of antigens and immunoglobulins; assess the significance of MHC and Hypersensitivity reactions.

UNIT I INTRODUCTION TO IMMUNOBIOLOGY 12

Introduction to biology of the immune system – Cells and Organs of Immune System. T and B lymphocytes – origin, development, differentiation, lymphocyte subpopulation in humans. Innate immunity- Complement, Toll-like receptors and other components. Acquired immunity – Active and Passive immunity.

UNIT II ANTIGENS 12

Antigens and immunogenicity- terminologies and definition- antigen, immunogen, haptens, super antigen, tolerance, epitope, paratope. Features associated with antigenicity and immunogenicity. Basis of antigen specificity. MHC – types and importance- distribution and function. Antigen processing and presentation to T- lymphocytes.

UNIT III IMMUNOGLOBULINS 12

Immunoglobulin- structure, types, distribution, biological and chemical properties - Theories of antibody production- its regulation and diversity. Monoclonal and polyclonal antibodies. Complement system – mode of activation- Classical, Alternate and Lectin pathways, biological functions.

UNIT IV IMMUNE RESPONSE 12

Antigen recognition – TCR, BCR, MHC restriction, lymphocyte activation, clonal proliferation and differentiation. Physiology of acquired immune response – various phases of HI, CMI – cell mediated cytotoxicity, DTH response.

UNIT V IMMUNE DYSFUNCTIONS AND IMMUNOTOLERANCE 12

Hypersensitivity – types and mechanisms, Autoimmunity and Transplantation immunology. Immune regulation mechanisms – brief account on immuno-induction, immuno- suppression, immuno-tolerance, immuno-potentiation. Role of cytokines, lymphokines and chemokines.

Total: 60 Lecture Hours

Course Outcome

At the end of the course, learners will be able to:

CO1: Appraise the fundamental concepts of immunity, contributions of the organs and cells in immune responses.

CO2: Elaborate on the functioning and interactions of the MHC molecules with host cells in response to an immune insult.

CO3: Discuss the functioning of antibodies and complement system

CO4: Analyze the role of immune system in health and disease

CO5: Associate the outcome of overreaction by our immune system

TEXTBOOK:

1. Richard Coico, Geoffrey Sunshine, Eli Benjamini. Immunology – A Short Course. Wiley-Liss, New York. 5th ed., 2003.

REFERENCE BOOKS:

1. Ivan M. Roitt, J. Brostoff and D. K. Male, Immunology, Gower Medical Publishing, London.1993.
2. Clark WR, The experimental foundations of modern immunology. John Wiley and Sons Inc. New York. 1991.
3. Janis Kuby, Immunology, II edition. W. H. Freeman and Company, New York. 1993.
4. Janeway Travers, Immunobiology- the immune system in health and disease. Current Biology Ltd. London, New York. 3rd ed.,1997.
5. Peter J. Delves, Ivan M. Roitt, Encyclopedia of Immunology; Academic Press. 2nd Ed., 1998.

6. Chapel H and Halbey M, Essentials of Clinical Immunology. ELBS. 1986.
7. Leslie Hudson and Frank C. Hay. Practical Immunology. Blackwell Scientific Publication. 3rd ed., 1989.
8. Pravash Sen. Gupta, Clinical Immunology. Oxford University Press. 2003.
9. Noel R. Rose, Herman Friedman, John L. Fahey. Manual of Clinical Laboratory Immunology. ASM. 3rd ed., 1986.

21CMIM13 CC3: General Microbiology 3 0 0 3

Course Objective: The candidates undertaking this course will gain knowledge about the structure of bacteria; types of microscopes and microscopy; sterilization methods and quality control; disinfection, antibiotics – testing and quality control; alga structure and life-cycle patterns.

UNIT I INTRODUCTION 9

Evolution and scope of microbiology. Description of various groups of microorganisms with typical example. Cell cycle and reproduction of bacteria. Bacterial cell structure and components, bacterial growth curve in batch culture.

UNIT II MICROSCOPY 9

Microscopy – principles of microscopy- bright-field microscopy – PCM, FM CLSM, ICM, TEM, SEM and STEM – description, principle and use. Staining methods – Differential staining, special staining of bacteria, fungi. Specimen preparation and staining for electron microscopy – SEM, TEM.

UNIT III STERILIZATION 9

Sterilization – High temperature- Tyndallization, Pasteurization, inspissation, incineration, moist heat under pressure; low temperature – preservation; filtration- membrane filters, depth filters; centrifugation; radiation- principle, use and Quality control. Disinfection- Mode of action of disinfectants; evaluation of action or quality of disinfectants.

UNIT IV ANTIBIOTICS 9

Antibiotics – Classification, Mode of Action, mechanism of resistance, Evaluation – Disc Diffusion; MIC – Broth dilution, agar dilution; MBC; E- test with Quality control for each method.

UNIT V ALGAE 9

Structure of algal cell with example; Life-cycle patterns of Algae. Reproduction in algae. Structure of *Paramecium, Amoeba, Euglena, Giardia*. Nutritional requirements and conditions for Cultivation of bacteria, fungi, virus. Culture media: Bacteria, Fungi. Cultivation of anaerobes.

Total: 45 Lecture hours

Course Outcome

At the end of the course, learners will be able to:

CO1: Assess the characteristics of microbes.

CO2: Discuss about the control of microorganisms.

CO3: Choose appropriate staining methods.

CO4: Distinguish the various groups of microorganisms.

CO5: Establish protocols for cultivation of microbes.

TEXTBOOK:

Michael T. Madigan, John M Martinko, Brock's Biology of Microorganisms, Pearson-Prentice Hall. Ed. 11; 2006.

REFERENCE BOOKS:

1. Ananthanarayanan R & C.K.Jeyaram Paniker; Textbook of Microbiology;Orient Longman. Ed.7;
2005.
2. Michael T. Madigan, John M Martinko; Brock's Biology of Microorganisms, Pearson-Prentice Hall. Ed. 11; 2006
3. Ronald M.Atlas; Principles of Microbiology, WCB Publishers. Ed. 2; 1997
4. Roger Y. Stanier, John L. Ingraham, Mark L. Wheelis,Page R. Painter, General Microbiology, MacMillan Press. Ed. 5; 2004.

5. Topley & Wilson's: Principles of Bacteriology, Virology & Immunology, Edward Arnold. Ed. 9; 2002.

6. Lansing M. Prescott, John P Harley, Donald A. Klein; Microbiology, McGraw Hill. Ed. 6; 2005.

21PMIM121 **CC3A: Practical - Microbiology** **0 0 2**

Course Objective: The candidate will gain hands-on knowledge and acquire adequate skill required to stain and observe microbes, identify pathogens and other bacteria based on biochemical reactions.

1. Staining – Simple, Gram's Staining, Acid fast Staining, Metachromatic granule staining, staining of lipid, Endospore staining, Staining of flagella, Capsule staining. Observation of motility – Wet mount; Hanging drop
2. Sterilization of antibiotic solution. Methods for testing effectiveness of antibacterial antibiotics – Kirby-Bauer method.
3. Biochemical tests: IMViC test, O-F Test, Sugar fermentation test.
4. Preservation of bacterial cultures.
5. Cultivation of anaerobes.
6. Bacterial typing methods- Serotyping, phage typing and bacteriocin typing methods.
7. KOH examination of skin, hair and nail infections.LPCB examination of fungi.Isolation and identification of fungi- *Mucor*, *Rhizopus*, *Aspergillus*, *Penicillium*, Dermatophytes and Yeasts - SDA/ Corn meal agar - Slide culture technique - Germ tube test – Capsular and Gram stain – Sugar assimilation and fermentation tests for yeasts.

Total: 30 Practical Hours

Course Outcome

At the end of the course, learners will be able to:

CO1: Acquire technical skills on staining methods.
CO2: Know how to perform sterilization and antibiotics sensitivity tests
CO3: Gain the basic skill on identification of bacteria and culture methods
CO4: Skilled in identification pathogenic bacteria, fungi and protozoa
CO5: Gain the knowledge on collection & transport specimens

21PMIM12 CC4: Practical - Immunology and Systemic Bacteriology 0 0 4 2

Course Objective: The candidate will gain hands-on knowledge and acquire adequate skill required to identify and enumerate immune cells and also perform agglutination reactions.

1. Identification of various immune cells by morphology – Leishman staining, Giemsa staining.
2. Heamagglutination Reactions- Blood Grouping – forward and reverse, Rh Typing, Coomb's test, TPHA.
3. Agglutination Reactions- Latex Agglutination reactions- RF, ASO, CRP.
4. Passive Agglutination Assay
5. Detection of HBs Ag by ELISA
6. Collection and transport of specimens- Faeces, pus, sputum, throat/ ear/ nasal/ wound swab, CSF and other body fluids.
7. Identification of medically important pathogenic bacteria- *Staphylococci, Streptococci, E. coli, Klebsiella, Shigella, Salmonella, Vibrio.*
8. Examination of parasites in clinical specimens- Ova/ cyst in faeces by Lugol's iodine wet mount method. Concentration methods- Formol ether and Zinc sulphate methods, Salt saturation methods.
9. Cultivation of viruses by egg inoculation methods. Observation and interpretation of CPE.
10. Blood smear examination for malarial parasites.
11. Separation of Leucocytes from Spleen

Total: 60 Practical hours

Course Outcome

At the end of the course, learners will be able to:

CO1: Discriminate various immune cells and enumerate them

CO2: Evaluate antigen concentration.

CO3: Choose appropriate method for identification of parasites

CO4: Assess viral growth

CO5: Distinguish and identify bacterial pathogens

REFERENCES

1. Leslie Hudson and Frank C. Hay. Practical Immunology. Blackwell Scientific Publication. 3rd ed., 1989.
2. Hay FC and Westwood OMR. 2002. Practical Immunology. 4th Edition. Blackwell Science.
3. Talwar GP and Gupta SK. 2017. A Handbook of Practical and Clinical Immunology. Vol. 1. 2nd edition.
4. Collee, J. G., Mackie, T. J., & MCCartney, J. E. (1996). Mackie & McCartney practical medical microbiology. New York, Churchill Livingstone Harvard (18th ed.)

21CMIM21 CC5: Microbial Genetics and Molecular Biology (Theory) 4 0 0 4

Course Objective: The candidate will gain knowledge about chromosomes, nucleic acids; DNA damage and repair; RNA and transcription; genetic code and recombination; Plasmids and cloning vectors; methods in molecular analysis.

UNIT I MICROBIAL GENETICS 18

Transformation, conjugation and transduction. Nucleic acid as genetic material – DNA and RNA structure. Melting of DNA. DNA replication – general principles, modes of replication, DNA polymerases – structure and function. Superhelicity in DNA, topology of DNA and topoisomerases, chromosome structure and organization. Replication of ssDNA, retroviral replication. Replication of chromosomal DNA in fungi. Inhibitors of replication. DNA damage and repair – Types of DNA damage, mechanism of repair - methyl directed, excision, recombinational, SOS.

UNIT II TRANSCRIPTION 10

Transcription – general principles, basic apparatus, RNA polymerases and steps involved, inhibitors of RNA synthesis. RNA maturation and processing in eukaryotes: Monocistronic and polycistronic mRNAs. Regulation of transcription – attenuation and antitermination, heat shock proteins. Structure of tRNA.

UNIT III TRANSLATION 10

Genetic Code. Translation in prokaryotes and eukaryotes – Molecular mechanism of Initiation, Elongation and Termination, Sigma- factor switching, post translational modifications of proteins. Operon concept – *lac*, *trp* and *ara* operon, riboswitches. Recombination – Molecular events in Generalized recombination, Site-specific recombination; Models of recombination.

UNIT IV MUTATION 12

Biology of plasmids, structure of F1, Col E1. pSC 101, Ti plasmid – their replication. Transposons – structure, types and functions. Gene as a unit of mutation and recombination – mutagens, mutagenesis – biochemical basis of mutations – spontaneous and induced. Reversion, suppression, genetic analysis of mutants. Fine structure and genetic analysis of phage T4 using rII locus. Genetic mapping of *E. coli* and yeast.

UNIT V MOLECULAR ANALYSIS 10

Methods to study biomolecules – Gel electrophoresis, 2D- Gel electrophoresis, Ion-exchange Chromatography, Gel filtration Chromatography, Affinity Chromatography, Autoradiography, Southern Blot, DNA Fingerprinting and Typing, Western Blot, Restriction mapping, Site-directed mutagenesis, Northern Blot, S1 Mapping, Nuclear Run-on Transcription, Reporter

Gene Transcription, Filter binding assay, Gel Mobility Shift, DNase Footprinting.

Total: 60 Lecture Hours

Course Outcome

At the end of the course, learners will be able to:

CO1: Write about the genetic material transfer mechanisms in microbes.

CO2: Explain mechanism of DNA replication and the various features of retrovirus replication.

CO3: Explain the processes of DNA to protein.

CO4: Distinguish different types of the extra chromosomal elements and transposons.

CO5: Select suitable methods for biomolecular analysis.

TEXT BOOK:

1. Freifelder, D; Molecular Biology. Narosa Publishing House, New Delhi. 2008.

REFERENCE BOOKS:

1. Maloy S.R, Cronan JR, JE. Freifelder, D; Microbial Genetics. Jones and Barlette publishers. 1994.
2. Lodish H, Baltimore O, Berk A, Zipursky SL, M Atsudaira P, Darnell, J.; Molecular Cell Biology. Scientific American Books. 1995.
3. Lewin B; Genes VIII. Oxford University Press. 2004.
4. William Haynes; The Genetics of Bacteria and Their Viruses. Blackwell Scientific Publishers, Oxford. 1985.

5. E.D.P. De Robertis, E.M.F. De Robertis,Jr., Cell And Molecular Biology, Lippincott Williams and Wilkins. Ed. 8; 2001.
6. B.Alberts, A,Johnson, J.Lewis, M.Roff, K.Roberts, P.Walter, Mol;ecular Biology of The Cell, Garland science,NY. Ed. 4; 2002.

21PMIM21 CC8: Practical - Molecular Biology 0 0 4 2

Course Objective: The candidate will gain hands-on knowledge and acquire adequate skill required to isolate, demonstrate and quantitate nucleic acids, transfer DNA to bacteria and separate biomolecules by electrophoresis.

1. Isolation of genomic DNA. Isolation of plasmid DNA – Alkaline lysis. Isolation of DNA from Fungi.
2. Quantitation of DNA and RNA by chemical methods-Dinitrophenol, orcinol, physical method – UV adsorption
3. Preparation of competent cells. Gene transfer by conjugation method.
4. Estimation of proteins – Lowry method; Bradford method
5. Electrophoretic methods – PAGE native PAGE.
6. TLC – Plant pigments, amino acids, lipids and vitamins. Protein separation by aqueous two phase partitioning.
7. Blotting techniques – Southern blotting and western blotting
8. Strain Improvement - Protoplast and spheroplast fusion, mutation.
9. PCR-standard amplification.
10. Isolation of antibiotic resistant microbes. Isolation of auxotrophic mutants.
11. Screening test for production of Cellulases, Amylases and Proteases, purification and assay.
12. Whole cell and enzyme immobilization. Biogas production. Mushroom cultivation. Wine preparation.

Total Hours: 90 Practical Hours

Course Outcome

At the end of the course, learners will be able to:

CO1: Acquire technical skills on isolation of DNA & Plasmid & their quantification

CO2: Know how to perform gene transfer, protein quantification & TLC

CO3: Gain the basic skill on blotting techniques & PCR

CO4: Skilled in production of microbial enzymes

CO5: Gain the knowledge on strain improvement and enzyme immobilization

21CMIM22 CC6: Molecular Immunology and Immunogenetics (Theory) 4 0 0 4

Course Objective: The candidate will gain knowledge about genes that control properties of immunoglobulin, complement proteins; TCR and other similar markers; MHC/ HLA genes and antigenic structure; ABO and other grouping systems; tumor antigens.

UNIT I IMMUNOGLOBULINS 12

Genetics of Immunoglobulins – isotypes, class switching, Molecular biology of immunoglobulin - biosynthesis, generation of antibody diversity, allotypes, and idiotypes.

UNIT II LYMPHOCYTES 12

Genetics of T – lymphocytes – Surface receptors, Antigens – Diversity of TCR, T cell surface alloantigens, other markers of Human T and B lymphocytes.

UNIT III MAJOR HISTOCOMPATIBILITY COMPLEX 12

Major Histocompatibility antigens – MHC genes and products, Structure of MHC molecules, Genetics of HLA Systems – Antigens and HLA typing. Genetics of complement components.

UNIT IV IMMUNOHEMATOLOGY 12

Genetics of Immunohematology – Genetic basis and significance of ABO and other minor blood groups in humans, Bombay blood groups, Secretors and Non-secretors, Rh System and genetic basis of D- antigens. Clinical and forensic relevance of ABO and minor blood groups.

UNIT V TUMOR ANTIGENS 12

Genetics of neoplastic cell antigens – TL antigens, CEA and others in humans, expression of tumour antigens and humoral and cell – mediated immune responses against tumour antigens in humans.

Total: 60 Lecture Hours

Course Outcome

At the end of the course, learners will be able to:

CO1: Explain the genetic basis of immune cell receptors, proteins involved in humoral and cell mediated immune response

CO2: Compare the generation of diversity in antibodies and T Cell Receptors.

CO3: Elaborate on oncogenes and expression of tumor antigens and explain immune response to tumors.

CO4: Highlight the role of MHC genes and products.

CO5: Discuss in-depth the genetics, clinical / forensic significance of human blood groups and types.

TEXTBOOK:

Christiansen**,** Frank T**.,** Tait**,** Brian D.**;** Immunogenetics: Methods and Applications; Springer. 2012.

REFERENCE BOOKS:

1. Benacerraf B, Immunogenetics and Immunodeficiency; William Clowes and Sons ltd. London. 1975.
2. Zaleski MB, Dubiski S, Niles EG and Cunningham RK, Immunogenetics; Pitman, Toronto. 1983.
3. Hugh Fudenberg H, Pink JRL, Wang A and Ferrera GB, Basic Immunogenetics; Oxford University Press , NY. 1984.
4. Williamson AR and Turner MN, Essential Immunogenetics; Blackwell Scientific Pulications, London. 1987.
5. K.S.N. Reddy, The Essentials of Forensic Medicine and Toxicology, Ed. 26; 2007.

21CMIM23 CC7: Medical Mycology and Parasitology 4 0 0 4

Course Objective: The candidate will gain knowledge about fungal pathogens, their diagnosis and treatment. They will also know about role of protozoans, and helminths in human health.

UNIT I FUNGAL PROPERTIES 12

Fungi - Structure and cell differentiation- unicellular and multicellular forms. Modes of reproduction -sexual, asexual and para sexual, life cycle patterns. Growth requirements and cultivation. Virulence factors. Detection and recovery of fungi from clinical specimens. Advances in diagnostic mycology. Antifungal agents- type and mode of action, testing methods and quality control. Immunity to fungal infection.

UNIT II MYCOSES 12

Superficial Mycoses- Dermatophytosis, Piedra, Pityriasis versicolor, Tinea nigra. Subcutaneous Mycoses- Mycetoma, Sporotrichosis, Chromoblastomycosis, Phaeohypomycosis, Rhinosporidiosis. Histoplasmosis, Blastomycosis, Coccidiodomycosis and Paracoccidiodomycosis. Opportunistic mycoses-Candidiasis, Cryptococcosis, Aspergillosis, Zygomycosis, Dimatiaceous fungi.

UNIT III PROTOZOOLOGY 12

Host – parasite relationship, Lab diagnosis of parasitic infections. Pathogenic mechanism, transmission, life cycle, lab diagnosis of Protozoans – *Entamoeba, Giardia, Trichomonas, Balantidium.*

UNIT IV HAEMOFLAGELLATES 12

Trypanosomes- *Leishmania, Trypanosoma* and Sporozoites- *Plasmodium.* Coccidia- *Toxoplasma, Cryptosporidium.*

UNIT V HELMINTHOLOGY 12

Cestodes - *Taenia solium* and *T. saginata, Echinococcus*. Trematodes – *Fasciola hepatica, Fasciolopsis buski, Paragonimus, Schistosoma*. Nematodes – *Ascaris, Ancylostoma, Trichinella, Trichuris, Strongyloides, Enterobius,* Filarial worms- *Wucheriria, Brugia, Loa Loa, Dracunculus, Onchocerca;* and other parasitic infections in immunocompromised hosts and AIDS associated parasites.

Total Hours: 60 Lecture Hours

Course outcomes (CO)

At the end of the course, learners will be able to:

CO1: Differentiate fungi based on morphological characters

CO2: Summarize the mode of action and assess the activity of different antifungal agents

CO3: Summarize the Pathogenesis, Clinical manifestation, Laboratory diagnosis and treatment of various fungal diseases

CO4: Summarize the interactions between the host and the parasite

CO5: Summarize the Pathogenesis, Clinical manifestation, Laboratory diagnosis and treatment of various parasites

TEXTBOOK:

Chatterjee; Medical Parasitology. CBS Publishers. 13th Edn 2019.

Jagadish Chandar; A textbook of Medical Mycology. Jaypee Brothers Medical Publishers. 4th Edn, 2018.

REFERENCE BOOKS:

1. D.R. Arora & B.R. Arora Medical Parasitology, CBS Publishers 5th Edn., 2018.
2. Subhas Chandra Parija, Medical Parasitology, 4th Edn., 2013.
3. Jayaram Panicker, Textbook of Parasitology, C.K. Jaypee Brothers, 8th Edn 2018.
4. Gerald D. Schmidt & Larry S. Roberts. Foundations of Parasitology, 6th Edn., 2008.
5. Alexopoulos C.J; Introductory Mycology. Wiley, 4th Edn 2007.
6. H.C. Dube, An introduction to Fungi, Scientific Publishers. 4rd Edn., 2012.
7. Alexopoulos C.J. & H.C. Bold. Algae & Fungi. MacMillan & Co Ltd, London.2001.
8. Ainsworth G.C; A Dictionary of the Fungi. Commonwealth Mycological Institute, Kew. Surrey. 1971.
9. Bilgrami K.S., Verma R.N; Physiology of Fungi, Scientific Publishers. 3rd Edn., 2011.

21PMIM223 **CC9: Practical-Immunotechnology** **0 0 6**

Course Objective: The candidate will gain hands-on knowledge and acquire adequate skill requiredtoperformprecipitationreactionsandpurifyimmunoglobulinsanddetectantigensvia western blotting.

1. Precipitation reactions in gels– Ouchterlony double immunodiffusion (ODD) and Mancini's single radial immunodiffusion (SRID)
2. Immunoelectrophores is and staining of precipitation lines- Rocket Immunoelectrophores and counter current Immunoelectrophores
3. Preparation of lymphocytes from peripheral blood by density gradient centrifugation.
4. Nylon Wool Separation of T and B Lymphocytes
5. Purification of immunoglobulin– Ammonium Sulphate Precipitation.
6. Separation of IgG by chromatography using DEAE cellulose or Sephadex.
7. Western Blotting.
8. HLA – DNA Typing.

Total: 90 Practical Hours

Course Outcome

At the end of the course, learners will be able to:

CO1: Evaluate Antigen-antibody interactions demonstrated in gels

CO2: Evaluate lymphocytes from blood by density gradient centrifugation

CO3: Analyze immunoglobulins by salt precipitation and affinity chromatography.

CO4: Analyze Molecular detection of infectious proteins by blotting techniques.

CO5:Analyze Molecular typing of tissues.

REFERENCES

1. Leslie Hudson and Frank C. Hay. Practical Immunology. Blackwell Scientific Publication. 3rd ed., 1989.
2. Hay FC and Westwood OMR. 2002. Practical Immunology. 4th Edition. Blackwell Science.

3. Talwar GP and Gupta SK. 2017. A Handbook of Practical and Clinical Immunology. Vol. 1. 2nd edition.

21CMIM31 CC10: Clinical Immunology and Vaccinology 4 0 0 4

Course Objective: The candidate will gain knowledge about immunological against infections; humoral and cell mediated immunity; autoimmunity mechanisms and damage; immunodiagnostic tests and assays; Vaccines-preparations and use.

UNIT I OVERVIEW OF MICROBIAL PATHOGENS 12

Microbial pathogens – Bacterial, Viral and Fungal Pathogens and Parasitic diseases. Bacterial- extracellular bacteria, Facultative and obligate intracellular bacteria. Fungal pathogens- Diseases- pathogenicity and virulence. Viral pathogens-Cellular infection and Pathogenicity. Parasitic diseases- Parasitism, and parasitic infections, Host-parasite interactions.

UNIT II INFECTION AND IMMUNITY 12

Immunity against bacterial infections – Innate and Acquired Immune responses – cellular involvement – Macrophages, Neutrophils, NK cells, Defensins, Humoral and Cell mediated Immune responses, Intracellular infections. Immunity against viral infections – Innate and Acquired immune responses. Immunity to fungal and parasitic infections – overview of Humoral and Cell mediated immune responses against the pathogens.

UNIT III CLINICAL IMMUNOLOGY 12

Clinical Immunology - Disease caused by immune response – hypersensitivity, immune tolerance and autoimmunity- mechanism of autoimmunity. Immunodeficiency-Primary immunodeficiency and Secondary immunodeficiency's. Immunosuppression and Immunomodulation.

UNIT IV IMMUNODIAGNOSIS 12

Diagnostic Immunology - Methods based on precipitation - Precipitation reaction, Immuno diffusion methods- SRID, ODD. Immunoelectrophoresis - Rocket and Counter current electrophoresis. Methods based on Agglutination- Haemagglutination - Haemagglutination inhibition. Labeled Assay- Immunofluorescence assay, Radio immunoassay, FISH, ELISA.

UNIT V VACCINES 12

Introduction to Vaccines and Adjuvants - Types of vaccines – Whole cell - Killed and Live Attenuated vaccines. Sub–unit vaccines- polysaccharides, proteins, Toxoids. Recombinant vector vaccines, DNA vaccines, Development of vaccines and antibodies in plants. Vaccines against AIDS and Tropical Infectious Diseases- Leprosy, malaria and TB. Vaccines for control of fertility , Anti-HCG Vaccines and Anti – sperm antigen vaccine. Immunization- Active and Passive. Immuno therapy for cancer. Strategies of vaccine production.

Total: 60 Lecture Hours
Course Outcome

At the end of the course, learners will be able to:

CO1: Write the adverse effect of immune system

CO2: Evaluate innate and adaptive immunity.

CO3: Explain the immunological response against microbial pathogens

CO4: Apply basic techniques for identifying antigen antibody interactions.

CO5: Analyze the reasons for immunization and aware of different vaccination

TEXTBOOK:

Mark Peakman, Basic and Clinical Immunology; Churchill Livingstone. 2nd Ed. 2009.

REFERENCE BOOKS:

1. Talwar GP, Rao KVS and Chauhan VS, Recombinant and Synthetic Vaccines; Narosa, New Delhi. 1994.
2. Benjamini E, Coico Rand Sunskise G,;I mmunology–A short course, Wiley–Liss Publication, NY. Ed.4; 2000.

3. Kuby J, Immunology, WH Freeman and Co. NY.Ed.4; 1997.

4. ClarkWR,The Experimental Foundations of Modern Immunology; JohnWiley and Sons Inc. New York. 1991.

5. Leslie Hudson and Frank C. Hay., Practical Immunology. Wiley. Ed.3; 1989.

6. Noel R. Rose, Herman Friedman, John L. Fahey., Manual of Clinical *Laboratory Immunology. ASM. Ed.3;*1986.

21CMIM32 Soil Microbiology 4 0 0 4

Course Objectives: The candidate will gain knowledge about the role of microbes in soil, especially, rhizosphere, phyllosphere. Nutrient cycling with emphasis on role of various groups of microorganisms at different stages of various cycles. Nitrogen fixation - Biofertilisers, biopecticides and plant pathology**.**

UNIT I INTRODUCTION 12

Introduction to soil microorganisms – Bacteria (Cyanobacteria and Actinobacteria), algae, fungi, protozoans and viruses – Role of microbes in soil fertility. Physical properties of soil. Types of soil. Soil structure. Soil enzymes and soil sickness.

UNIT II PLANT MICROBES INTERACTION 12

Microbial associations in phytosphere: rhizosphere, rhizoplane – phyllosphere, phylloplane – spermosphere. Mycorrhiza – types and importance to agriculture – organic matter decomposition – humus formation. Association in Lichens. PGPR and role in soil.

UNIT III PLANT PATHOLOGY 12

Plant pathology – Host and pathogen interaction. Transmission of plant pathogen. Various symptoms of plant diseases. A brief account of symptoms, etiology, life cycles and

management of microbial diseases to crop plants (Rice, sugarcane, groundnut, Tomato, potato, wheat, banana, grapes and pulses).

UNIT IV BIOPESTICIDES 12

Plant growth promoting rhizobacteria – Biological control of phytopathogens – Mechanism of control – *Trichoderma* sp. and P*seudomonas fluorescens* as biocontrol agents – Disease suppressive soils – Biopesticide and their importance: Bacterial, fungal and viral. Bioinsecticide formulation and characterization: *Bacillus thuringiensis*.

UNIT V BIOGEOCHEMICAL CYCLES 12

Biogeochemical cycles – carbon, nitrogen, phosphorus, sulphur cycles; nitrogen fixers – root nodule formation – nitrogenase, hydrogenase – biochemistry of nitrogen fixation.

Total: 60 Lecture Hours

Course Outcome

At the end of the course, learners will be able to:

CO1: Write about the role and importance microbes in soil and agriculture.

CO2. Develop the protocol for the mass production and applications of bio fertilizer and their impact on plant growth

CO3: Analyze about the plant microbes interactions.

CO4: Evaluate the importance and impact of pesticides.

CO5: Evaluate the importance of biogeochemical cycles

TEXTBOOKS:

1. Vijaya Ramesh ; Soil and Agricultural Microbiology, MJP Publishers; 2004.
2. P. D. Sharma, Environmental Microbiology, Narosa Publications Limited. 2005.

REFERENCE BOOKS:

1. Subba Rao N.S.; Soil Microorganisms and Plant Growth, Oxford and IBH publication Co. Pvt. Ltd. New Delhi. 2002.
2. Cambell. R., Microbial Ecology., Blackwell Scientific Publication. London. 2nd edition, 1983.
3. Mitchell.R.; Introduction to Environmental Microbiology, Prentice – Hall. Inc. Cliffs - New Jersey. 2003.

4. N.S.Subba Rao. Soil Microbiology and Biochemistry. Oxford and IBH Publication Pvt. Ltd. 1998.
5. N.S. Subba Rao, Biofertilizer in Agriculture and Forestry, Oxford and IBH publication. 3rd edn, 2005.
6. Lynch , J.M. and Poole, Microbial Ecology. A Concept Approach, BI scientific publication London. 2005.
7. Rheinheimer, Aquatic Microbiology. John Wiley and sons, Chichester. 2nd edn. 2008.
8. Ronald. M. Atlas, Richard Bartha, Microbial Ecology. Fundamental and application, An imprint of Addison Wesley Longman Inc. 4th ed, 1998.
9. Joseph. C. Daniel, Environmental Aspects of Microbiology, Brightsun Publications. 1st ed, 2006.
10. Ec Edowrly.S, Hardman OJ and Wait S, Pollution: Ecology and Biotreatment, Longman Scientific Technical. 1993.
11. Baker KH and Herson OS, Bioremediation, Mc Graw Hill, NY. 1994.

21CMIM33 CC11: Environmental Microbiology (Theory) 4 0 0 4

Course Objectives: The candidate will gain knowledge about microbes in air, air sanitation and quality assessment. Types of water ecosystems and water-borne diseases. Effluent treatment and parameters – BOD, COD. Extremophiles in the environment.

UNIT I INTRODUCTION 11

Microbiology of air; droplet, droplet nuclei, aerosol, infectious dust. Assessment of air quality. Laboratory hazards of air microbes, air borne diseases, air sanitation. Aero mycology.

UNIT II AQUATIC MICROBIOLOGY 13

Aquatic Microbiology- aquatic ecosystems- fresh water (ponds, lakes, streams), marine ecosystem (estuaries, mangroves, deep sea, salt pan, coral reef); Eutrophication. Potability of water, assessment of water quality, purification of drinking water. Water borne diseases-pathogenesis, prevention and control.

UNIT III WASTE WATER MICROBIOLOGY 12

Waste water Microbiology- types and characteristics of waste, BOD, COD. Liquid waste treatment- primary, secondary, tertiary treatment, disinfection and disposal, Solid waste treatment- composting, saccharification and gasification, pyrolysis, incineration.

UNIT IV MICROBES IN ECOSYSTEM 12

Microbial communities and role of microbes in ecosystem (primary producer and decomposer). Adaptations of microbes in extreme environment- thermophile, psychrophile, halophile, acidophile, alkalophile, barophile, osmophile.

UNIT V RECALCITRANCE AND BIOREMEDIATION 12

Recalcitrance and biodegradation of recalcitrant compounds. Biodegradation of xenobiotic compounds. Bioaccumulation of heavy metals, biomagnification, biocorrosion, bioleaching and biomining. Bioremediation.

Total: 60 Lecture Hours

Course Outcome

At the end of the course, learners will be able to:

CO1: To estimate and gain knowledge on the role and infections caused by microbes in air.

CO2: To create and obtain detailed information on aquatic ecosystems and Assimilate knowledge on Water borne diseases.

CO3: To construct detailed knowledge on Waste water treatment and its different methods.

CO4: To evaluate basic understanding on different types of microbes present in the environment and its uses.

CO5: To estimate and acquire knowledge on Biodegradation, of xenobiotic compounds and Understand of Biomagnification and Bioremediation.

TEXTBOOK:

Ronald. M. Atlas, Richard Bartha, Microbial Ecology. Fundamental and application, An imprint of Addison Wesley Longman Inc. 4th ed, 1998.

REFERENCE BOOKS:

1. Joseph. C. Daniel, Environmental Aspects of Microbiology, Brightsun

Publications. 2nd. Ed., 2006.

2. Dr. K. Vijaya Ramesh, Environmental Microbiology, MJP Publishers. 1st Ed, 2004.
3. A. J. Salle, Fundamental Principles of Bacteriology, Tata McGraw Hill Publishing Company. 7th Ed, 1990
4. Paul Singleton, Diana Sainsbury, Dictionary of Microbiology and Molecular Biology, John Wiley and Sons. 2nd ed, 1997.
5. P. D. Sharma, Environmental Microbiology, Narosa Publications Limited. 1st Ed, 2005.
6. Edowrly.S, Hardman OJ and Wait S, Pollution: Ecology and Biotreatment, Longman Scientific Technical. 1993.
7. Baker KH and Herson OS, Bioremediation, Mc Graw Hill, NY. 1994.
8. R. C. Dubey and D. K. Maheswari, Practical Microbiology, S, Chand & Co Ltd, New Delhi. 1st ed, 2008.

21PMIM31 Practical in Environmental Microbiology and Vaccine preparation 0 0 4 2

Course Objectives: The candidate will gain hands-on knowledge and acquire adequate skill required to evaluate the microbiological quality of water and air.

1. Enumeration of microbes in air- settle plate method
2. Enumeration of microbes in air- Reuters Air sampler
3. Estimation of BOD and COD.
4. MPN for coliforms in water as per - BAM, APHA, IS Standards.
5. Isolation of feacal coliform from water.
6. Enumeration of microbes in water using membrane filter.
7. Crude preparation of bacterial antigens and raising antibodies in animal models.
8. Repetitive bleeding techniques
9. Bacterial Agglutination assay
10. Field trip to sewage treatment plants, coastal area, salt pans, coral reef.
11. Visit to Regional Vaccine Institutes

Total: 60 Lab hours

Course outcome

At the end of the course, learners will be able to:

CO1: Construct a procedure to raise antibodies in animal models.

CO2: Develop protocols for air sampling.

CO3: Evaluate oxygen demand in water.

CO4: Analyze microbial quality of water.

CO5: Compare water quality as per various standards.

REFERENCES:

1. Joseph. C. Daniel, Environmental Aspects of Microbiology, Brightsun Publications. 2nd. Ed., 2006.
2. Dr. K. Vijaya Ramesh, Environmental Microbiology, MJP Publishers. 1st Ed, 2004.
3. Leslie Hudson and Frank C. Hay., Practical Immunology. Wiley. Ed.3; 1989.
4. Noel R. Rose, Herman Friedman, John L. Fahey., Manual of Clinical *Laboratory Immunology. ASM. Ed.3;*1986.

21CMIM41 rDNA Technology and Nanomicrobiology 4 0 0 4

Course Objectives: The candidates will understand rDNA technology and strategies involved in genetic manipulations. The candidates will also gain knowledge on ethical issues involved in the system. Studying nanomicrobiology, the students will get necessary background information on nanotechnology in microbiological perspective and gain knowledge on nanoprocesses.

UNIT I GENETIC ENGINEERING 12

An overview of Genetic engineering- Isolation & purification of DNA from cells. Restriction enzymes, DNA ligases, DNA modifying enzymes. Agarose gel electrophoresis and SDS – PAGE. Pulse field electrophoresis for large DNA. Characteristics of an ideal vector, cloning vectors – Plasmids, phages, Cosmids, Phagemids, Artificial chromosomal vectors, Shuttle vectors; choice of vectors for *E. coli*, fungi, higher plants and mammalian cells.

UNIT II GENE TRANSFER 12

Methods of gene transfer- Electroporation, transduction, and liposome mediated gene transfer. Direct transfer of DNA- Microinjection, particle bombardment. Screening of recombinants- Insertional inactivation and complementation, blue-white screening, immunodetection and radioactive probes. Strategies for obtaining the clone of choice- Direct selection – selection from gene library. Construction of cDNA libraries.

UNIT III APPLICATIONS OF rDNA TECHNOLOGY 12

Strategies for obtaining the clone of choice- Direct selection – selection from gene library. Construction of cDNA libraries. Uses of cloning in medicine, agriculture, forensic science and industries. Socio-economic ethics of cloning, NIH guidelines, GEO, GMF, future of cloning techniques.

UNIT IV NANOMICROBIOLOGY 12

Basics of Nanomicrobiology- introduction, landmarks in nanomicrobiology- Techniques: microarrays- nanoarrays- protein nanoarray- microfluidics and nanofluidics. Atomic force microscopy- operation- advantages of AFM, Magnetic resonance force microscopy.

Nanoparticles- Quantum dots, Gold nanoparticles, Silica nanoparticles, Fluorescent nanoparticles, cubosomes, Dendrimers, nanoparticle synthesis.

UNIT V NANOBIOTECHNOLOGY 12

Bacterial structures relevant to nanobiotechnology- Nanostructures on bacterial cell surface-bacterial magnetic particles- DNA nanotubes. Quantum dots for cell labeling and study of apoptosis. Nanoprobes for Analytical Applications. Nanomicrobiology in drug delivery- viruses as nanomaterials for drug delivery- Bacteria mediated drug delivery-Dendrimers- Cubosomes- Gold nanoparticles- cyclodextrin.

Total hours: 60 Lecture Hours

Course Outcomes:

At the end of the course, learners will be able to:

CO1: Create a manual for manipulation of nucleic acids.

CO2: Evaluate about the hosts and vectors in gene cloning.

CO3: Develop the methods on gene transfer and screening of recombinants.

CO4: Summarize the characteristics of clone selection and ethical issues of cloning.

CO5: Evaluate the process, characters and applications of nanoparticles.

TEXTBOOK:

T.A. Brown, Gene Cloning and DNA Analysis- An Introduction, Blackwell Science Publishers.Ed.4; 2001.

REFERENCE BOOKS:

1. Old, R.S and Primrose SB, Principles of Gene manipulation: An Introduction to Genetic engineering , Blackwell Scientific publications.Ed.5;1995.
2. Glick B.R and Pasternak JJ, Molecular Biotechnology. ASM Press, Washington DC.1994.
3. Clover D.M , DNA cloning series (Vol I-IV); IRL Press, Oxford.1987.
4. Winnacker E L, From Genes to clones: Introduction to Gene technology; VCH Weinheim.1987.
5. Satyanarayana. U, Biotechnology; Uppala- Author Publishers Linkers.2005.
6. Tuan R.S , Recombinant Gene Expression Protocols; Humana Press.1997.

DISCIPLINE SPECIFIC ELECTIVES (DSE)

21DMIM11 DSE1: Medical Bacteriology and Virology 4 0 0 4

Course Objectives: The candidates will understand pathogenesis, diagnosis, treatment and prevention of viral and bacterial infections. Upon successful completion, the course will enable the students to assess these concepts and interpret the solutions for epidemic and pandemic diseases.

UNIT I VIRAL PROPERTIES 12

General properties of viruses, Structure of Adenovirus, Influenza virus, HIV, HBV, Ebolavirus. Cultivation of virus – Egg inoculation, Cell culture methods. Viral diagnosis techniques – Electron Microscopic techniques, Immunological, Cytopathic Effects and Molecular Methods for viral detection.

UNIT II VIRAL DISEASES 12

Pathogenesis, clinical findings, prevention, control and treatment of following viruses HIV, HAV, HBV, Rabies, Influenza, Dengue, Mumps, Rubella, Polio, Corona and Oncogenic Virus. Antiviral agents, chemotherapy and vaccines. Viriods, prions, virusoids and satellite RNA.

UNIT III SYSTEMIC BACTERIOLOGY 12

Normal flora of human body. General attributes and virulence factors of bacteria causing infections – invasiveness and toxigenicity. Pathogens, pathogenesis, clinical manifestations, lab diagnosis, epidemiology, chemotherapy and prevention of following diseases based on portal of entry: *Via* respiratory tract – Pneumonia, bronchitis, rheumatic fever, diphtheria, whooping cough, tuberculosis, meningitis. Via gastrointestinal tract – Botulism, gastroenteritis, enterocolitis, typhoid, cholera. Via genitourinary tract – Urinary tract infections, gonorrhea, syphilis, non – gonococcal urethritis.

UNIT IV SYSTEMIC BACTERIOLOGY AND COSMIC BACTERIA 12

Plague, Relapsing Fever, Leprosy, Leptospirosis, Gas gangrene, Tetanus, Infections of eye: Trachoma, conjunctivitis; Infections of oral cavity. Miscellaneous bacteria – *Listeria, Campylobacter, Helicobacter, Legionella,* etc. Cosmic Bacteria and Significance in Space Bacteriology.

UNIT V ANTIBIOTIC RESISTANCE AND DIAGNOSTIC TECHNIQUES 12

Antibiotics and chemotherapeutic agents – drug resistance and antibiotic policy. Epidemiology and control of community infections. Nosocomial infections – factors that influence hospital infection, hospital pathogens, routes of transmission, investigation, prevention and control. Recommendations for the collection, transport and isolation of bacteria from clinical specimens. General principles, media and isolation techniques involved for anaerobic bacteria.

Total Hours: 60 Lecture Hours

Course Outcome

At the end of the course, learners will be able to:

CO1: Assess the importance and significance of antimicrobial resistance and control measures.
CO2: Appraise the epidemiology and control of community acquired and nosocomial infections.
CO3: Discuss about the characters, pathogenicity and lab diagnosis of bacterial pathogens.
CO4: Appraise out the role of space microbes in human health.
CO5: Establish and discuss in-depth the pathogenesis, lab diagnosis and treatment of viral infections.

TEXTBOOK:

1. Sastry Apurba S & Bhat Sandhya, 2020; Essentials of Microbiology, Jaypee Brothers.

References:

1. Jawetz. E, Melnick J.L, Adelberg E.A ,1998; Review of Medical Microbiology, Ed. 19; Lange Medical Publications, ELBS, London.
2. David Greenwood, Richard B. Slack John F. Peutherer, 2002; Medical Microbiomlogy, Ed.16; Churchill Livingstone, London.
3. Baron EJ, Fine Gold S.M, 1995; Diagnostic Microbiology; Blackwell Scientific

Systems.

4. J.G. Colle, A.Simmons, A.G. Fraser, B.P. Marmion, 2006; Mackie & McCartney Practical Medical Microbiology, Ed.14; Elsevier.
5. Cowan & Steel, 1995; Cowan & Steel's Manual for Identification of Medical Bacteria, Ed.4; Cambridge University Press, London
6. Wolfgang, Joklik &David J. Smith, 1990; Zinsser's Microbiology, Ed.11; Appleton Century Crafts, N.Y.
7. Topley & Wilson, 1990; Topley & Wilson's Principles of Bacteriology, Virology & Immunity, Vol III; Bacterial Diseases, Ed.8; Edward Arolla, London.

21DMIM12 DSE3: Industrial Microbiology 4 0 0 4

Course Objectives: The candidate will gain knowledge role of microbes in production of industrially important products through the use of fermentation media. They will also learn about types of bioreactors and product separation technologies.

UNIT I INTRODUCTION TO INDUSTRIAL MICROBIOLOGY 6

Brief history and developments in industrial microbiology. Importance of microbial products over chemically synthesized products – ill effects of chemicals.

UNIT II SCREENING AND FERMENTATION MEDIA 12

Sources of industrially important microbes and methods for their isolation, preservation and maintenance of industrial strains, strain improvement, inoculum development. Crude and synthetic media; molasses, corn steep liquor, sulphite waste liquor, whey, yeast extract and protein hydrolysates

UNIT III FERMENTATION PROCESSES 12

Concept of Fermentation technology. Types of fermentation processes - Solid-state and liquid-state (stationary and submerged) fermentations; batch, fed-batch (eg. baker's yeast) and continuous fermentations Components of a typical bio-reactor, Types of bioreactors- Laboratory, pilot- scale and production fermenters, constantly stirred tank and air-lift fermenters, Measurement and control of fermentation parameters - pH, temperature, dissolved oxygen, foaming and aeration

UNIT IV DOWN-STREAM PROCESSING 12

Cell disruption, filtration, centrifugation, solvent extraction, precipitation, lyophilization and spray drying, Enzyme immobilization- Methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes (glucose isomerase and penicillin acylase)

UNIT V MICROBIAL PRODUCTION OF INDUSTRIAL PRODUCTS 18

Microbial production of: chemotherapeutic agents - penicillin, streptomycin, tetracycline; Organic acids- Citric acid, gluconic acid; Amino acids- L-Glutamic acid, L- Tryptophan, L-

Lysine; Enzymes-amylase, protease, lipase. Production of Wine, beer, ethanol and Vitamin B12. Methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes

Total Hours: 60 Lecture Hours

Course Outcome

At the end of the course, learners will be able to:

CO1: Write the importance of microbial products over chemically synthesized products
CO2: Develop knowledge on important microbial strains and fermentation media
CO3: Design fermenters and fermentation processes.
CO4: Explain about downstream processing and industrial production of various products.
CO5: Apply knowledge on Microbial production of industrial products

TEXTOOK:

1. Patel A.H. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited

REFERENCE BOOK:

1. Okafor N. (2007). Modern Industrial Microbiology and Biotechnology. 1st edition. Bios Scientific Publishers Limited. USA
2. Waites M.J., Morgan N.L., Rockey J.S. and Higton G. (2001). Industrial Microbiology: An Introduction. 1st edition. Wiley – Blackwell

3. Glaze A.N. and Nikaido H. (1995). Microbial Biotechnology: Fundamentals of Applied Microbiology. 1st edition. W.H. Freeman and Company
4. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
5. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
6. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Wiley.

21DMIM21 DSE3: IMMUNOTECHNOLOGY 4 0 0 4

Course Objective: The candidate will gain knowledge of antigen-antibody interactions and cellular assays. This course focuses on the use of antibodies in biotechnical applications with a special emphasis on technologies for production of antibodies and isolation/purifying with protein.

UNIT I ANTIGEN-ANTIBODY REACTIONS 12

Antigen-Antibody reactions- Precipitation reaction, Immunodiffusion methods-SRID, ODD. Agglutination reaction- Principle, types and application. Electro-Immunodiffusion Immunoelectrophoresis- Rocket immunoelectrophoresis, counter current immunoelectrophoresis, Immunofixation. .

UNIT II ANTIGENS AND IMMUNOGLOBULIN PURIFICATION TECHNIQUES 12

Preparation of antigens-bacterial, fungal, viral pathogens-different methods. Standardization and quantification of antigens. Raising of polyclonal antibodies in animals-different routes of inoculation- immunization protocol. Purification and quantification of immunoglobulins.

UNITIII MOLECULAR ENGINEERING 12

Molecular engineering methods–improve and modify immunological specificities and reactions. Antigen engineering for better immunogenicity and use for vaccine development. Antibody engineering–Hybridoma Technology, recombinant DNA technology for antibody engineering-humanized, chimeric antibodies-bispecific antibodies-Application

UNITIV IMMUNOASSAYS 12

Separation of immune cells-T cells-B cells. Density gradient-lymphocyte stimulation test-Delayed Type Hypersensitivity estimation methods-macrophage migration inhibition assays-purification and assay of interleukins.

UNITV IMMUNOTECHNIQUES 12

ELISpot, Immuno histochemistry, Western blot, Flow cytometry-T cell subset analysis- B cell analysis. Immunolabelled Assay- Immuno-fluorescence assay, Radioimmuno Assay, ELISA –principle- typical protocol -types-Application.

Total: 60 Lecture Hours

Course Outcome

At the end of the course, learners will be able to:

CO1: Develop immunological techniques and their applications in biotechnical industry

CO2: Design approaches for immune intervention

CO3: Evaluate polyclonal, monoclonal and humanized antibodies and production of these

CO4: Analyze achieved results of immunological serum analyses by means of ELISA

CO5: Analyze the principles of immunoassays.

TEXTBOOK:

D.P.Stites,J D Stobo,H.H.Fudenberg, J.V.Wells; Basic and Clinical Immunology. Lange Medical Publications. Ed.8; 2006.

REFERENCE BOOKS:

1. Pravash Sen. Gupta, Clinical Immunology; Oxford University Press. 2003.
2. Noel R. Rose, Herman F riedman, John L. Fahey, Manual of Clinical Laboratory Immunology. ASM.IIIedition; 1986.
3. Leslie Hudson and Frank C. Hay, Practical Immunology, Blackwell Scientific

Publication. Ed.3; 1989.

4. Goding J.W., Monoclonal Antibodies: Principle and Practice; Academic Press. 2001.
5. Carl A. K. Borre bacck, Antibody Engineering, Oxford University Press. Ed.2; 1995.
6. LeonoreA.Herzenberg,Donald M.Weir, LeonardA. Herzenberg ,Caroline Blackwell, Weir's Hand book of Experimental Immunology,Vol .I–IV;BlackwellScience.1996.
7. StefanH.E. Kaufmann and Dieter Kabelitz, Immunology of Infection. Methods in Microbiology. Vol. 25; AcademicPress. 1998.
8. Sringer,T.A,Hybridoma Technology in the Biosciences and Medicine; Plenum Press. New York. 2004.
9. GarrisonFathman.C.,Fitch,F.W.,Isolation,CharacterizationandUtilizationofT lymphocyte clones; Academic Press. 2003.
10. .P.Talwar and S.K.Gupta.,A Handbook of Practical and Clinical Immunology,Vol.I- I; CBS Publishers and Distributors. Delhi. 1993.

21DMIM31 DSE4: Biofertilizers Technology 4 0 0 4

Course Objective: The candidate will gain knowledge about significance of biofertilizers; various beneficial microbes like nitrogen fixers, Mycorrizhal associations and organic farming.

UNIT I INTRODUCTION 12

Introduction; General account about the microbes used as biofertilizer – Rhizobium – isolation, identification, mass multiplication, carrier based inoculants, Actinorrhizal symbiosis. Seaweed biofertilizer production.

UNIT II NITROGEN FIXERS 12

Azospirillum Isolation and mass multiplication – carrier based inoculant, associative, effect of different microorganisms. Azotobacter: classification, characteristics – crop response to Azotobacter inoculum, maintenance and mass multiplication.

UNIT III ASSOCIATIONS 12

Cyanobacteria (blue green algae); *Azolla* and *Anabaena*- azollae association, nitrogen fixation, factors affecting growth, blue green algae and *Azolla* in rice cultivation.

UNIT IV MYCORRHIZA 12

Mycorrhizal association Types of mycorrhizal association, taxonomy, occurrence and distribution, phosphorus nutrition, growth and yield – colonization of VAM – isolation and inoculum production of VAM, and its influence on growth and yield of crop plants.

UNIT V ORGANIC FARMING 12

Organic farming Green manuring and organic fertilizers, Recycling of biodegradable, municipal, agricultural and Industrial wastes – biocompost making methods, types and method of vermicomposting – field application.

Total: 60 Lecture Hours

Course Outcome

At the end of the course, learners will be able to:

CO1: Summarize the structure of Nucleic acid.

CO2: Summarize the mechanism of DNA replication, transcription and translation processes in organisms.

CO3: Summarize the mechanisms of gene expression and its regulations in organisms.

CO4: Summarize the mutations and DNA repair mechanisms in organisms.

CO5: Summarize the transposable elements, types of plasmids and its applications.

TEXTBOOK:

P.C.Trivedi, Biofertilizers; Neha Publishers. 2008.

REFRENCE BOOKS:

1. Dubey, R.C., A Text book of Biotechnology S.Chand & Co, New Delhi. 2005.

2. Kumaresan, V., Biotechnology, Saras Publications, New Delhi. 2005.

3. John Jothi Prakash, E., Outlines of Plant Biotechnology. Emkay Publication,

4. New Delhi. 2004.

5. Sathe, T.V., Vermiculture and Organic Farming. Daya Publishers.2004. Subha Rao, N.S. Soil Microbiology, Oxford & IBH Publishers, New Delhi.2000.

6. Vayas,S.C, Vayas, S. and Modi, H.A. Bio-fertilizers and or ganic Farming Akta Prakashan, Nadiad.1998.

7. H.C.Lakshmi, Biofertilizers & Biopesticides; Neha Publishers. 2014.

21DMIM32 DSE5: Food Microbiology 4 0 0 4

Course Objectives: The candidate will gain knowledge about food preservation and spoilage. Upon successful completion of the course, the students will get insights of food genomics and culture independent methods for monitoring food borne microbes; Sanitation procedures in food and dairy industries; Food-borne diseases and its control.

UNIT I INTRODUCTION 12

Scope of food microbiology. Microorganisms important in food microbiology- molds, yeasts and bacteria – Probiotic bacteria, Functional Foods. Food Genomics and the gut microbiome. Factors influencing microbial growth and survival in foods – intrinsic and extrinsic factors. Common spoilage organisms in food.

UNIT II FOOD PRESERVATION METHODS 12

Principles of food preservation – Asepsis, Removal of microbes, maintenance of anaerobic conditions. Methods – physical- heat-processing, canning process, low temperature- chilling, freezing, high pressure, controlled and modified atmosphere, drying, irradiation. Chemical methods- use of preservatives, food additives. Hurdle Concept.

UNIT III MICROBIAL SPOILAGE AND CONTROL 12

Spoilage of foods – Meat, Eggs, Sea foods, Fruits, Vegetables and Grains. Food Sanitation- Controlling microbiological quality of foods- Total Quality Management (TQM), sampling schemes, control at source, GMPs, GHPs. Quality Systems – Global Food Safety Initiative (GFSI), Hazard Analysis and Critical Control Point system (HACCP), International Food Standard (IFS), British Retail Consortium (BRC), Safe Quality Food (SQF) 2000 and International Organization for Standardization ISO 9000; 22000:2018.

UNIT IV MICROBIOLOGY OF MILK AND DAIRY PRODUCTS 12

Microbiology of milk and dairy products- contamination, spoilage and preservation of dairy products. Fermented dairy products – cheese and its types, butter, yoghurt, butter milk, acidophilus milk, kefir, koumiss. Microbes as food. Non-dairy products - Bread, wine, sauerkraut and vinegar. Milk- borne diseases.

UNIT V FOOD-BORNE DISEASES 12

Food microbiology and public health. Food hazards, Significance of food-borne diseases, Incidence and Risk factors. Bacterial and non-bacterial food borne infections and intoxications. Methods of microbiological examination of foods- indicator organisms, direct examination, culture dependent and culture independent techniques. Packing of foods and foods for astronauts.

Total Hours: 60 Lecture Hours

Course Outcome

At the end of the course, learners will be able to:

CO1: Validate the interactions between foods and microorganisms and their influence on gut microbiome.

CO2: Explain the different methods of food preservation and types of spoilage in foods.

CO3: Elaborate on food sanitation and quality systems adopted in food industries.

CO4: Identify the role of microbes in the production of dairy and non-dairy products.

CO5: Classify bacterial and non-bacterial food borne diseases.

TEXTBOOKS:

Adams MR and Moss MO, Food Microbiology. New Age International Publishers.2005

REFERENCE BOOKS:

1. Frazier WC and Westhoff DC, Food Microbiology. Tata McGraw Hill Publishing Company Limited. New Delhi. 1988.
2. Sivasankar, B. Food Processing and Preservation, Prentice Hall of India Pvt. Ltd. 2002.
3. James M. Jay, Modern Food Microbiology, CBS Publishers and Distributors. New Delhi. 1996.
4. Board, RC. A Modern Introduction to Food Microbiology. Blackwell Scientific Publications, Oxford. 1983.
5. Ananthakrishnan CP, Singh RB, Padmanabhan PN, Dairy Microbiology, Sri Lakshmi Publications, Chennai. 1994.
6. Robinson RK. Dairy Microbiology, Wiley and Sons. New York. 2002.
7. Salle, A.J. Fundamental Principles of Bacteriology. Tata McGraw Hill Publishing Company Ltd. 7th Ed., 2001.
8. Samuel C. Prescott, Cecil G. Dunn. Industrial Microbiology, Agro Bios India. 2005.
9. Michael P. Doyle, Larry R. Beuchat, Thomas J. Montville. Food Microbiology-Fundamentals and Frontiers. ASM Press. 2nd Edition. 2001.

21DMIMxx DSE6: MEDICAL MICROBIOLOGY (Theory) 4 0 0 4

Course Objective: The candidate will gain knowledge about pathogenesis, diagnosis, control and treatment of medically important – viral diseases; bacterial diseases; fungal diseases; and parasitic infections.

UNIT I VIROLOGY 12

General properties of viruses Structure, cultivation, pathogenesis and various diagnosis techniques. Antiviral agents, chemotherapy and vaccines. Viroids, prions, virusoids and satellite

RNA. General properties, antigenic structure, pathogenesis, clinical findings, lab diagnosis, prevention, control and treatment of - HIV, HAV, HBV, Rabies, Influenza, Dengue, Yellow Fever, Measles, Mumps, Rubella, Polio, Oncogenic Viruses.

UNIT II BACTERIOLOGY 12

Normal flora of human body. General attributes and virulence factors of bacteria causing infections – invasiveness and toxigenicity. Pathogens, pathogenesis, clinical manifestations, lab diagnosis, epidemiology, chemotherapy and prevention of diseases caused by– *Staphylococcus*, *Streptococcus*, *C. diphtheriae, Cl. tetani, Cl. botulinum, B.pertussis, M. tuberculosis, N. gonorrhea, S. typhi, V. cholera , S. dysentriae, T. pallidum*. Y. *pestis*, *Leptospira interrogans.*

UNIT III INFECTION 12

Epidemiology and control of community infections. Nosocomial infections – factors that influence hospital infection, hospital pathogens, routes of transmission, investigation, prevention and control. Hospital waste management.

UNIT IV MYCOLOGY 12

Detection and recovery of fungi from clinical specimens. Molecular and advanced diagnostic methods for mycological infections. Antifungal agents- testing methods and quality control. Yeasts of medical importance – *Candida, Cryptococcus sp.* Fungi of medical importance – Dermatophytes and Superficial mycoses, systemic mycoses, opportunistic mycoses, Dimatiaceous fungi, Eumycotic mycetoma.

UNIT V PARASITOLOGY 12

Introduction to parasitology, Host–parasite relationship, mechanism of pathogenesis, transmission and life cycle of the Protozoan – *Entamoeba, Toxoplasma, Cryptosporidium, Leishmania, Giardia, Trypanosoma, Trichomonas, Balantidium* and *Plasmodium*. Helminthes

– Cestodes – *Taenia solium* and *T.saginata, Echinococcus*. Trematodes – *Fasciola hepatica, Fasciolopsis buski, Paragonium, Schistosomes*. Nematodes – *Ascaris, Ankylostoma, Trichuris, Trichinella, Enterobius, Wucheriria*.

Total: 60 Lecture Hours

Course Outcome

At the end of the course, learners will be able to:

CO1: Write about the properties, pathogenicity, lab diagnosis of pathogenic viruses.

CO2: Evaluate bacterial pathogens based on the characters, pathogenicity and lab diagnosis.

CO3: Discriminate nosocomial infections.

CO4: Appraise various fungal pathogens.

CO5: Analyze pathogenic protozoans and helminths

TEXTBOOK:

Jawetz. E, Melnick J.L, Adelberg E.A , Review of Medical Microbiology, Lange Medical Publications, ELBS, London. Ed. 28; 2013.

REFERENCE BOOKS:

1. Ananthnarayanan. R & C. K. Jeyaram Panicker, Textbook of Microbiology,;Orient Longman. Ed.8; 2006.
2. David Greenwood, Richard B. Slack John F. Peutherer Medical Microbiology, Churchill Livingstone, London. 16th Edn., 2002.
3. Baron EJ, Fine Gold S.M; Diagnostic Microbiology. Blackwell Scientific Systems. 1995.
4. J.G. Colle, A.Simmons, A.G. Fraser, B.P. Marmion, Mackie & McCartney Practical Medical Microbiology, Elsevier.Ed.14; 2006.
5. Topley & Wilson, Topley & Wilson's Principles of Bacteriology, Virology & Immunity, Vol III; Bacterial Diseases, Edward Arolla, London. Ed.8; 1990.
6. Jagadish Chandar, 1996; A Textbook of Medical Mycology; Interprint, New Delhi.
7. Alexopoulos C.J, Introductory Mycology; John Wiley & Sons Inc, N.Y. 1992.
8. H.C. Dube , Introduction to Fungi, Vikas Publishing House. Ed.3; 2005.
9. D.R. Arora & B.R. Arora Medical Parasitology, CBS Publishers & Distributors, New Delhi. 1st Edn., 2002.
10. Subhas Chandra Parija, Medical Parasitology, 2nd Edn., 2009.

21DMIMxx DSE7: Industrial and Pharmaceutical Microbiology (Theory) 4 0 0 4

Course Objective: The candidate will gain knowledge about industrially important organisms, strain improvement; production of major products involving microbes; biogas, biofuels; Antimicrobials production; Immobilization and sterilization.

UNIT I INTRODUCTION 12

Introduction to industrial microbiology. Study of industrially important microbes- yeast, *Lactobacillus*, *Hansenula, Spirulina, Dunaliela, Haematococcus, Streptomyces, Penicillium.* Methods for the improvement of microbial strains having industrial value. Fermenter- basic function, design and components, types of fermenter, types of fermentation.

UNIT II PRODUCTION 12

Production of organic acids- vinegar, citric acid, vitamins- riboflavin, cyanocobalamine, amino acid- glutamic acid, lysine, enzymes- cellulases, amylases, pectinases, proteases. Mushroom cultivation, production of SCP (Spirulina, yeast). Production of fermented food- dairy and non-dairy products. Production of microalgae and macroalgae.

UNIT III EFFLUENT TREATMENT 12

Production of biogas, biofuel. Production of non-microbial products through microbes- insulin, interferon, B-cell growth factor. A brief mention about effluent treatment in industries using microbes. Petroleum Microbiology- organisms involved. Introduction to antibiotics. Mode of action of antibiotic-cell wall, cell membrane, nucleic acids, protein synthesis, enzyme inhibition.

UNIT IV DRUG 12

Important microbes producing antimicrobial agents, synthetic antimicrobial agents, antifungal agents and antitumor agents. Drug targeting, drug delivery system in gene therapy. Resistant to antibiotics-bacteria, yeast. Sterilization of pharmaceutical products, contamination and spoilage of pharmaceutical products. Other pharmaceutical products produced by microbes (streptokinase, streptodornase, Botox).

UNIT V PHARMACEUTICAL APPLICATIONS 12

Immobilization procedure for pharmaceutical applications (liposomes), biosensors in pharmaceuticals. Applications of microbial enzymes in pharmaceuticals. Regulatory aspects of

quality control. Sterilization, control and sterility testing (Heat sterilization, D-value, Z-value, radiation, Gaseous and filter sterilization), chemical and biological indicators used.

Total: 60 Lecture Hours

Course Outcome

At the end of the course, learners will be able to:

CO1: Write about industrially important microbes, fermenters.

CO2: Develop protocols for industrial production of Organic acids, Amino acids and enzymes.

CO3: Evaluate the various methods for production of Biofuel, Biogas, and Insulin.

CO4: Choose optimal method for microbial production of pharmaceuticals.

CO5: Assess outcomes and regulatory aspects of quality control.

TEXTBOOK:

Arnold .L, Demain and Davis. J. E., Manual of Industrial Microbiology and Biotechnology; ASM Press. Washington DC. 1999.

REFERENCE BOOKS:

1. Stanbury. P .F, Whitaker. A. Hall. S. J, Principles of Fermentation Technology; Pergamon Press. 1995.
2. Reed. G, Prescott and Dunn's Industrial Microbiology; Macmillan Publishers. 1982.
3. W.B. Hugo and A. D. Russell, Pharmaceutical microbiology, Blackwell scientific Publications; Ed. 6; 2002.
4. Fredrick Kavanagh, Analytical microbiology, Vol I & II;Academic press, New York. 2003.
5. Murray. S. Cooper, Quality control in pharmaceutical industry, Vol 2; Academic press, New York. 2001.
6. S.P.Vyas, V.K. Dixit, Pharmaceutical Biotechnology; CBS publishers and Distributors, New Delhi. 2004.
7. Rajesh Bhatia, Ratanlal Ihhpunjani, Quality assurance in Microbiology; CBS publishers and distributors, New Delhi. 2005.

21DMIMxx DSE9: Cloning Strategies and Nanomicrobiology (Theory) 4 0 0 4

Course Objective: The candidate will gain knowledge about genetic engineering; gene transfer mechanisms and related phenomena; various cloning strategies; nanomicrobiology and nanotechnologies.

UNIT I GENETIC ENGINEERING 12

An overview of Genetic engineering- Isolation and purification of DNA from cells – Total, plasmid and phage DNA. PCR, Pulse field electrophoresis for large DNA. Restriction enzymes, DNA ligases, DNA modifying enzymes, Eukaryotic and Prokaryotic hosts for cloning. Characteristics of an ideal vector, cloning vectors – Plasmids, phages, Cosmids, Phagemids, Artificial chromosomal vectors, Shuttle vectors, choice of vectors for *E. coli*, fungi, higher plants and mammalian cells.

UNIT II GENE TRANSFER 12

Methods of gene transfer- Electroporation, transduction, and liposome mediated gene transfer. Direct transfer of DNA- Microinjection, particle bombardment. Screening of recombinants- Insertional inactivation and complementation, blue-white screening, immunodetection and radioactive probes.

UNIT III STRATEGIES 12

Strategies for obtaining the clone of choice- Direct selection – selection from gene library. Construction of cDNA libraries. Uses of cloning in medicine, agriculture, forensic science and industries. Socio-economic ethics of cloning, NIH guidelines, GEO, GMF, future of cloning techniques.

UNIT IV NANOMICROBIOLOGY 12

Basics of Nanomicrobiology- introduction, landmarks in nanomicrobiology- Techniques: microarrays- nanoarrays- protein nanoarray- microfluidics and nanofluidics. Atomic force microscopy- operation- advantages of AFM, Magnetic resonance force microscopy. Nanoparticles- Quantum dots, Gold nanoparticles, Silica nanoparticles, Fluorescent nanoparticles, cubosomes, Dendrimers, nanoparticle synthesis.

UNIT V NANOBIOTECHNOLOGY 12

Bacterial structures relevant to nanobiotechnology- Nanostructures on bacterial cell surface- bacterial magnetic particles- DNA nanotubes. Applications in Biology- NanoSystems Biology- Quantum dots for cell labeling and study of apoptosis- Nanofabricated structures for DNA separation- Nanopore sequencing- Nanomotor from DNA (Molecular motor). Nanoprobes for Analytical Applications-A new Methodology in medical diagnostics and Biotechnology- Nanosensors. Nanomicrobiology in drug delivery- viruses as nanomaterials for drug delivery- Bacteria mediated drug delivery-Dendrimers- Cubosomes- Gold nanoparticles- cyclodextrin.

Total: 60 Lecture Hours

Course Outcome
At the end of the course, learners will be able to:

CO1: Create a manual for manipulation of nucleic acids.

CO2: Evaluate about the hosts and vectors in gene cloning.

CO3: Develop the methods on gene transfer and screening of recombinants.

CO4: Understand the characteristics of clone selection and ethical issues of cloning.

CO5: Apply the various techniques in gene cloning

TEXTBOOKS:

1. L.E.Foster, Nanotechnology-Science, Innovation and Opportunity, Person education Inc, 2007.
2. Sardul Singh Sandhu; Recombinant DNA Technology;I K International Publishing House. 2010.

REFERENCE BOOKS:

1. T.A. Brown, Gene cloning and DNA analysis- An introduction, Blackwell Science Publishers. Ed.4; 2001.
2. Old, R.S and Primrose SB, Principles of Gene manipulation: An introduction to Genetic engineering , Blackwell Scientific publications. Ed.5; 1995.
3. Glick B.R and Pasternak JJ, Molecular Biotechnology. ASM Press, Washington DC. 1994.
4. Clover D.M , DNA cloning series (Vol I-IV); IRL Press, Oxford. 1987.
5. Winnacker E L, From Genes to clones: Introduction to Gene technology; VCH Weinheim. 1987.
6. Satyanarayana. U, Biotechnology; Uppala- Author Publishers Linkers. 2005.

7. Tuan R.S , Recombinant Gene Expression Protocols; Humana Press. 1997.
8. M.Ratner and D.Ratner, Nanotechnology –A Gentle Introduction to The Next Big Idea, Pearson Education. 2007.
9. Charles P. Poole, Jr. and Frank J. Owens, Introduction to Nanotechnology; Wiley-Interscience. 2003.
10. Guozhong Cao, Nanostructures and Nanomaterials: Synthesis, Properties and Applications; Imperial College Press. 2004.

21DMIMXX DSE11: Microbial Biochemistry 4 0 0 4

Course Objective: The candidate will gain knowledge about microbial ultrastructure and biomolecules, biochemical cycles; energy molecule formation; fermentations and transport mechanisms.

UNIT I ULTRASTRUCTURE 13

Ultra structure of bacteria, algae, protozoa, fungi and virus. Types of Linkages in biomolecules; configuration and forms of sugars, amino acids (biologically active forms).Chemistry of Carbohydrates, Proteins and Lipids; Enzymes – factors affecting enzyme activity.

UNIT II CYCLES 14

Photosynthesis in bacteria, Cyanobacteria. Electron transport and respiration in bacteria - aerobic and anaerobic; and eukaryotes. Adaptive response in bacteria- metabolic stress, temperature, pH, oxygen. Osmotic stress, extremophiles. C1 metabolism. EMP, ED Pathway; HMP Shunt, TCA cycle.

UNIT III ENERGY PRODUCTION 10

Energy production–Substrate-level phosphorylation; oxidative phosphorlation. Membrane - potential – chemiosmotic theory, conformational change hypothesis; mechanisms to generate and maintain membrane potential. ATP Synthesis. Biosynthesis of fatty acids.

UNIT IV FERMENTATION 12

Fermentation – Propionate, Acetate, Lactate, Mixed Acid, Butyrate and Butanediol. Assimilation and dissimilation of nitrogen and sulphate. Nitrogen fixation – nitrogen fixation process; components of nitrogenase system. Endospore formation, Life cycle of *Myxobacteria*, Life cycle of *Caulobacter*.

UNIT V TRANSPORT 11

Mechanism of locomotion by bacteria, Homeostasis in bacteria, Transport across membranes – Chaperons, Leader Sequence. Bacterial cell division. Biosynthesis of nucleic acids. Exotoxins, endotoxins and quorum sensing.

Total: 60 Lecture Hours

Course Outcome

At the end of the course, learners will be able to:

CO1: Write about locomotion and reproduction in bacteria.

CO2: Compare metabolic processes.

CO3: Evaluate the types of fermentation.

CO4: Appraise the unique biochemical pathways in bacteria.

CO5: Explain the adaptive responses in bacteria.

TEXTBOOK:

J.L. Jain, Fundamentals of Biochemistry; Chand Publications. 2006.

REFERENCE BOOKS:

1. Albert G.Moat, John W. Foster, Michael P.Spector, Microbial Physiology, John Wiley and Sons. Ed. 4; 2006.
2. David White, The Physiology and Biochemistry of Prokaryotes; Oxford University Press. 1995.
3. Michael T. Madigan, John M Martinko, Brock's Biology of Microorganisms, Pearson-Prentice Hall. Ed. 11; 2006.
4. Alberts B.Dray, J Lewis, M Raff, K Roberts, JD Watson, Molecular Biology of The Cell, Garland Publishing. Ed. 3; 1994.
5. Gottschalk G, Bacterial Metabolism, Springer-Verlag. Ed. 2; 1996.
6. Kates M, D Kushner, AT Matthews, The Biochemistry of Archae; Elseiver. 1993.
7. Topley and Wilson's : Principles of Bacteriology, Virology, and Immunology, Edward Arnold. Ed. 9; 2002.
8. Harper's Biochemistry; Robert.K. Murray Lance International Publication, 26th edition,

2005.

9. M.N. Chatterjee, Text Book of Medical Biochemistry; Jaypee Publication. 6th edition, 2006
10. U. Sathyanarayana, Biochemistry; Books and Allied (P) Ltd. 3rd edition, 2006.

21DMIMXX DSE12: Medical Parasitology (Theory) 4 0 0 4

Course Objective: The candidate will gain knowledge about the structure of protozoa and helminths; life-cycle patterns, pathogenesis, identification, and treatment.

UNIT I INTRODUCTION 11

Introduction to parasitology, Classification, Host – parasite relationship, Lab diagnosis of parasitic infections.

UNIT II PROTOZOOLOGY 12

Protozoology- pathogenic mechanism, transmission, life cycle, lab diagnosis of Protozoans – *Entamoeba, Giardia, Trichomonas, Balantidium.*

UNIT III HAEMOFLAGELLATES 12

Haemoflagellates- *Leishmania, Trypanosomes- Trypanosoma* and *Sporozoites-Plasmodium. Toxoplasma, Cryptosporidium.*

UNIT IV CESTODES 12

Helminthes – Cestodes – *Taenia solium and saginata, Echinococcus*. Trematodes – *Fasciola hepatica, Fasciolopsis buski, Paragonium, Trematodes- Schistosomes, Trichinella*.

UNIT V NEMATODES 13

Nematodes – *Ascaris, Ancylostoma, Trichuris, Strongyloides, Enterobius, Filarial worms- Wucheriria, Brugia, Loa Loa, Dracunculus, Onchocerca;* and other parasitic infections in immunocompromised hosts and AIDS associated parasites.

Total: 60 Lecture Hours

Course outcomes (CO)

At the end of the course, learners will be able to:

CO1: Formulate protocol to detect and recover parasites from clinical specimen

CO2: Differentiate parasites based on morphological characters

CO3: Summarize the Pathogenesis, Clinical manifestation, Laboratory diagnosis and treatment of various protozoans

CO4: Summarize the Pathogenesis, Clinical manifestation, Laboratory diagnosis and treatment of various helminths

CO5: Summarize the interactions between the host and the parasite

TEXTBOOK:

Chatterjee; Medical Parasitology. CBS Publishers. 2008.

REFERENCE BOOKS:

1. D.R. Arora & B.R. Arora Medical Parasitology, CBS Publishers & Distributors, New Delhi. 1st Edn., 2002.

2. Subhas Chandra Parija, Medical Parasitology, 2nd Edn., 2009.

3. Jayaram Panicker, Textbook of Parasitology, C.K. Jaypee Brothers, New Delhi. 2006.

4. Gerald D. Schmidt & Larry S. Roberts. Foundations of Parasitology, 6th Edn., 2008.

21DMIMXX DSE13: Research Methodology (Theory) 4 0 0 4

Course Objective: The candidate will gain knowledge about research methodology; Biostatistics; biomolecules; and various biotechniques.

UNIT I RESEARCH METHODOLOGY 12

Research methodology- Meaning, Course Objective and types of research. Different research designs- Experimental and Non- experimental. Review of literature- preparation of research report. Guidelines for preparing an article. Criteria of good research-problem encounters in research in India.

UNIT II BIOSTATISTICS 12

Biostatistics- collection, classification and presentation of data-graphical and diagrammatic presentation, measure of central tendencies (mean, median, mode), measure of dispersion (range, mean deviation, standard deviation) and qualitative methods of data analysis. Simple linear correlation and regression analysis- testing of hypothesis using t- test, chi-square test, analysis of variances and covariance- ANOVA.

UNIT III BIOMOLECULES 12

Nucleic acid blotting methods-PCR-principles-instrumentation –applications- primer design-Nucleic acid sequencing methods- direct PCR sequencing- automated fluorescent DNA sequencing. Protein estimation- UV-lowry method- Bradford- Kjeldahl analysis- purification methods- cell disruption- crude extract- fractionation methods. Enzyme assays-

spectrophotometric and manometric methods. Immobilization of enzymes- physical and chemical methods.

UNIT IV CENTRIFUGATION 12

Centrifugation techniques- principles- types of centrifuges and their uses-Refrigerated- High speed- Continuous flow- Preparative Ultracentrifuge- Differential- Density gradient and Analytical Ultracentrifuge. Spectroscopic techniques-Principles- Instrumentation – Applications- UV-Vis Spec- Spectrofluorimetry- Atomic absorption spectroscopy - Turbidometry and Nephelometry- Luminometry-NMR.

UNIT V BIOSEPARATION 12

Electrophoretic techniques-principles-Electrophoresis of proteins-SDS-PAGE- Native gels- Gradient gels- Isoelectric focusing gels- Two dimensional PAGE- Cellulose acetate electrophoresis-western blotting. Electrophoresis of Nucleic acids- Agarose gel- Pulse – field gel and Capillary electrophoresis.Chromatographic techniques- principles – materials and applications. Column-TLC-Low pressure column chromatography- HPLC- Adsorption – Partition and affinity chromatography- GLC.

Total: 60 Lecture Hours

Course Outcome

At the end of the course, learners will be able to:

CO1 To formulate the objective, types of research and guidelines for article writing.
CO2: To create and acquire knowledge about use of biostatistics and tools in research.
CO3: To develop the types, and properties of major biomolecules.
CO4: To evaluate the basic molecular techniques – PCR, blotting, Nucleic acid sequencing, Centrifugation, NMR, fluorescent DNA sequencing and Enzyme assays.
CO5: To estimate the bioseparation techniques.

TEXTBOOK:

Kothari CR; Research Methodology; New Age International Publishers, New Delhi. 2nd Edition; 2005.

REFERENCE BOOKS:

1. Keith Wilson and John Walker; Practical Biochemistry- principles and techniques, Cambridge University Press. 5th Edition, 2003.
2. John G. Webster; Bioinstrumentation. Student Edition, John Wiley and Sons Ltd. 2004.
3. Palanivev, P; Analytical Biochemistry and Separation Techniques- A laboratory manual, 2nd Edition. 2001.
4. Asokan P; Analytical Biochemistry (Biochemical techniques), 2001.
5. Gurumani N; Research Methodology for Biological sciences, MJP publishers, Chennai. 2006.
6. Wayne W Daniel; Biostatistics- A foundation for analysis in the health sciences. 7 th Edition, John Wiley and Sons Ltd. 2000.

21DMIMXX DSE14: Biostatistics (Theory) 4 0 0 4

Course Objective: The candidate will gain knowledge about biostatistics; collection of data, data correlation; regression analysis and variability.

UNIT I INTRODUCTION 12

Introduction to biostatistics – Definition, statistical methods, biological measurement, kinds of biological data, functions of statistics and limitation of statistics.

UNIT II DATA 12

Collection of data, sampling and sampling design, classification and tabulation, types of representations, graphic – bar diagrams, pie diagrams and curves.

UNIT III CORRELATION 12

Correlation – different types of correlation – positive, negative, simple, partial, multiple, linear and non-linear correlation. Methods of studying correlations.

UNIT IV REGRESSION 12

Regression, types and methods of analysis. Regression line, Regression equations, Deviation taken from arithmetic mean of X on Y, Deviation taken from the assumed mean.

UNIT V VARIABILITY 12

Measures of dispersion and variability, changes. Deviations – Quartile deviation, mean deviation, standard deviation, coefficient of variation, Lorenzen's curve.

Total: 60 Lecture Hours

Course Outcome

At the end of the course, learners will be able to:

CO1: To formulate and understand the concepts of Biostatistics.
CO2: To create the information on kinds of biological data and collection of data.
CO3: To construct in-depth information on Correlation.
CO4: To evaluate knowledge on Regression and types.
CO5: To estimate the knowledge on Deviations and graphic representations.

TEXTBOOK:

Khan, Fundamentals of Biostatistics, Uhaaz Publications, 1994.

REFERENCE BOOKS:

1. Palanisamy. S. and Manoharan, M. Statistical methods for Biologists (Biostatistics). Palani Paramount Publications, TamilNadu. 1994.

2. Arora, P.N. and Malhan, P.K. Biostatistics. Himalaya Publishing House, Mumbai. 1996.

3. Stanton. A.Clantz. Primer of Biostatistics – The McGraw Hill Inc. New York.1997.

4. Sokal and Rohlf. Introduction to Biostatistics – Toppan Co. Japan. 1973.

5. A. K. Vashisth. Encyclopedia of Biostatistics; Neha Publishers & Distributors. 2007.

21DMIMXX DSE15: Animal Cell Culture (Theory) 4 0 0 4

Course Objective: The candidate will gain knowledge about structure of animal cells; culture media and cultivation of animal cells; quantitation of cells and their applications.

UNIT I STRUCTURE 12

Structure and Organization of animal cell; Equipment and materials for animal cell culture technology; Primary and established cell line cultures; Introduction to the balanced salt solutions and simple growth medium.

UNIT II CULTURE MEDIUM 12

Brief discussion on the chemical, physical and metabolic functions of different constituents of culture medium. Role of carbon dioxide. Role of serum and supplements; Serum and protein free defined media and their application.

UNIT III QUANTITATION 12

Measurement of viability and cytotoxicity; Biology and characterization of the cultured cells, measuring parameters of growth;

UNIT IV CELL CULTURE 12

Basic techniques of mammalian cell culture in vitro; disaggregation of tissue and primary culture, maintenance of cell culture; cell separation.

UNIT V APPLICATIONS 12

Cell synchronization; Cell cloning and micromanipulation; Cell transformation; Application of animal cell culture; Scaling-up of animal cell culture. Stem cell cultures, embryonic stem cells and their applications; Cell culture-based vaccines, Somatic cell genetics.

Total: 60 Lecture Hours

Course Outcome

At the end of the course, learners will be able to:

CO1: Write about the structure and organization of animal cells and cell cultures.

CO2: Appraise the biology and characterization of the cultured cells.

CO3: Compare the different culture media used in animal cell culture.

CO4: Explain the maintenance of cell culture.

CO5: Classify animal cell types.

TEXTBOOK:

Mishra Bina, Animal Cell Culture.Studium Press. 2011.

REFERENCE BOOKS :

1.Basanth Kumar Sinha, Rinesh Kumar; Principles of animal Cell Culture. IBDC Press.2008.

2.Kumaresan, V., Biotechnology, Saras Publications, New Delhi. 2005.

3.John Masters, Animal Cell Culture: A Practical Approach. Oxford University Presss. 2000.

4.Ian Freshney.R, Culture of Animal Cells: A Manual of Basic Technique and Specialized Application. Wiley-Blackwell.2010.

21DMIMXX DSE16: Good Manufacturing Practices (Theory) 4 0 0 4

Course Objective: The candidate will gain knowledge about quality control and GMP; statistical basis for GMP; quality control systems and quality assurance.

UNIT I INTRODUCTION 12

Introduction to quality control History – Definition – quality in manufacturing and service system – Philosophy of quality management (Deming, Juran, Croshy and others) Red bead and funnel experiment.

UNIT II QUALITY CONTROL 12

Laboratory and quality control: Personnel training – Sampling procedures – Sample submittal

– Receipt and handling of samples – Analytical methods and method validation – equipment calibration and maintenance – Data validation and interpretation – reporting – documentation and sample retention – corrective action.

UNIT III STATISTICS 12

Statistical quality control: Descriptive statistics – confidence intervals – tests of mean – correlation – regression – ANOVA – x chart. HACCP, GMP, cGMP, GILSP, SSOP. Writing QA manual, Biosafety manual – SOPs – Inter laboratory QC program.

UNIT IV QUALITY SYSTEMS 12

International quality systems: Introduction to ISO family – ISO – 9001; ISO – 17025 – regulatory bodies of quality – Good laboratory practice. Six sigma concept. Quality frame work.

UNIT V QUALITY AUDITING 12

Quality auditing: Audit definition and fundamentals of auditing – preparation – performance – reporting – closure-post script – internal system audit - procedure- auditing check list.

Total: 60 Lecture Hours

COURSE OUTCOME (CO)

At the end of the course, learners will be able to:

CO1: Create procedure for internal system audit

CO2: Formulate Good manufacturing guidelines based on International quality systems

CO3: Formulate protocol for sample collection, analysis and validation in Quality control process

CO4: Summarize the Philosophy of quality management

CO5: Compile methods for equipment calibration and maintenance.

TEXTBOOK:

HACCP: A Systematic Approach to Food Safety. A Comprehensive Manual for Developing and Implementing a Hazard Analysis and Critical Control Point Plan. Virginia N. Scott and Kenneth E. Stevenson, Editors, Food Products Association, Fourth Edition, 2006.

REFERENCE BOOKS:

1. Shayne Cox Gad. Pharmaceutical Manufacturing Handbook, Published by John Wiley and Sons, Inc., 2008
2. Good manufacturing practices for pharmaceutical products. In: *WHO Expert Committee on Specifications for Pharmaceutical Preparations. Thirty-seventh report*. Geneva, World Health Organization, 2003 (WHO Technical Report Series, No. 908), Annex 4.
3. Validation of analytical procedures used in the examination of pharmaceutical materials. In: *WHOExpert Committee on Specifications for Pharmaceutical Preparations. Thirty-second report*. Geneva,World Health Organization, 1992 (WHO Technical Report Series, No. 823), Annex 5.
4. *EudraLex* – Volume 4. *Good manufacturing practice (GMP) Guidelines. European Commission*. (http://ec.europa.eu/health/documents/eudralex/vol-4/ index_en.htm).

GENERIC ELECTIVES (GE)

21GMIM41 GE1: PHARMACEUTICAL MICROBIOLOGY 4 0 0 4

Course Objectives: The candidate will gain knowledge about use of microbes in pharmaceutical industries, production of antibiotics and advanced drug delivery system and drug formulation regarding to guidelines and regulations

UNIT I INTRODUCTION 12

Ecology of microorganisms and pharmaceutical products – air, water, raw materials, packaging, buildings, equipment, cleaning equipment and utensils.

UNIT II STERILIZATION 12

Microbial contamination and spoilage of pharmaceutical products – infection risk and contamination control - and their sterilization. Sterility testing methods – specific inactivation, dilution, and membrane filtration.

UNIT III ANTIMICROBIAL AGENTS 12

Antibiotics - Natural and synthetic - antifungal agents, antitumor substances. Peptide antibiotics, Laboratory evaluation of antimicrobial agents- Mechanism of action of antibiotics and synthetic anti-infective agents. Clinical uses of antimicrobial drugs.

UNIT IV VACCINES 12

Manufacturing procedures in process control of pharmaceuticals. Other pharmaceuticals produced by microbial fermentations. New vaccine technology, DNA, synthetic peptide, multivalent subunit vaccines. Regulatory aspects of quality control.

UNIT V TESTING GUIDELINES AND REGULATIONS 12

Bioassay of antibacterial agents in liquid media and in agar media using standard guidelines (e.g. (NCCLS) / (CLSI)). Methodologies for testing of antimycobacterial, antifungal, antiparasitic and antiviral drugs (in vivo and in vitro infectivity models). Clinical studies: Phase I, phase II, phase III and phase IV of clinical trials – Objectives, Conduct of trials, Outcome of trials.

Total Hours: 60 Lecture Hours

Course Outcome:

At the end of the course, learners will be able to:

CO1: Summarize the Ecology of microorganisms and pharmaceutical products

CO2: Design the sterility testing methods in pharmaceutical Industry.

CO3: Learn about the laboratory evaluation of the antimicrobial agents

CO4: Develop the protocols for process control in pharmaceuticals.

CO5: Explain the regulations in terms of quality control of drugs

Textbook:

Stephen P Denver, Norman A Hodges, Sean P Gorman, Brendan F Gilmore (2011). Hugo and Russell's Pharmaceutical Microbiology, John Wiley and Sons, 8th edn

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2. Frederick Kavanagh (2014). Analytical Microbiology, Elsevier.
3. Vyas SP and Dixit VK (2010). Pharmaceutical Biotechnology, CBS Publishers & Distributors, New Delhi.
4. Joseph D Nally (2016). Good Manufacturing Practices for Pharmaceuticals, CRC Press, 6th edn.
5. Chakrabarty AM, Omenn and Gilbert S (1990). Biopharmaceuticals in Transition: Advances in Applied Biotechnology, Portfolio publisher, Vol. 10.
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7. Tille P (2015). Bailey & Scott's Diagnostic Microbiology-E-Book, Elsevier Health Sciences.
8. Saravanamuthu R (2010). Industrial Exploitation of Microorganisms, IK International Pvt Ltd.
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10. Dhanasekaran D, Thajuddin N and Panneerselvam A. eds., (2015). Antimicrobials: synthetic and natural compounds, CRC Press.
11. Denyer S, Russell A (2004). Non‐Antibiotic Antibacterial Agents: Mode of Action and Resistance, Hugo and Russell's: Pharmaceutical Microbiology, 7th Edn, 306- 22.
12. Denyer SP, Hodges NA and Gorman SP eds., (2008). Hugo and Russell's pharmaceutical microbiology, John Wiley & Sons.

21PGECXX GE2: Introduction and Scope of Microbiology (Theory) 2 0 0 2

Course Objectives: The candidates will understand the development of microbiology, diversity of microorganisms, Microscopy and other microbiological concepts.

UNIT I HISTORY OF DEVELOPMENT OF MICROBIOLOGY 6

Development of microbiology as a discipline, Spontaneous generation *vs*. biogenesis. Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming. Role of microorganisms in fermentation, Germ theory of disease,

UNIT II DIVERSITY OF MICROORGANISMS 6

Systems of classification : Binomial nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility. General characteristics of different groups: Acellular microorganisms and Cellular microorganisms giving definitions and citing examples.

UNIT III MICROSCOPY 6

Bright Field Microscope, Dark Field Microscope, Phase Contrast Microscope, Fluoresence Microscope,Transmission Electron Microscope, Scanning Electron Microscope.

Unit IV STERILIZATION 6

Moist Heat, Autoclave, Dry Heat, Hot Air Oven, Tyndallization, Filteration. Microorganisms as food (SCP), microorganisms in food fermentations (dairy and non dairy based fermented food products) and probiotics.

Unit V MICROBES IN HUMAN HEALTH AND ENVIRONMENT 6

Medical microbiology and immunology: List of important human diseases and their causative agents of various human systems. Environmental microbiology: Definitions and examples of important microbial interactions – mutualism, commensalism- parasitism

Total: 30 Lecture Hours

Course Outcome

At the end of the course, learners will be able to

CO1: Learn basics of microbiology

CO2: Learn about the significance of classification and features of microbes.

CO3: Able to suitably address the ways to view microbes and the role of fermentations in human activity.

CO4: Gain knowledge regarding control of microbes, uses and impact of microorganisms regarding food.

CO5: Comprehend the role of microorganisms in health and environment.

TEXTBOOK:

Ananthnarayanan. R & C. K. Jeyaram Panicker; TEXTBOOKS of Microbiology, Orient Longman. 2010.

REFERENCE BOOKS:

1. Tortora GJ, Funke BR and Case CL., Microbiology: An Introduction; Pearson Education. 9th edition.,2008.

2. Madigan MT, Martinko JM, Dunlap PV and Clark DP., Brock Biology of Microorganisms. Pearson International Edition. 14th edition. 2014.

3. Cappucino J and Sherman N., Microbiology: A Laboratory Manual. PearsonEducation Limited. 9th edition. 2010.

4.Wiley JM, Sherwood LM and Woolverton CJ. Prescott's Microbiology. McGrawHill International. 9th Edition. 2013.

5. Atlas RM., Principles of Microbiology. 2nd edition. WM.T.Brown Publishers. 1997.

6. Pelczar MJ, Chan ECS and Krieg NR., Microbiology. McGraw Hill Book Company. 5th edition. 1993.

7. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR., General Microbiology. McMillan. 5th edition. 2005.

21PGECXX GE3: Bacteriology and Virology (Theory) 2 0 0 2

Course Objectives: The candidates will understand the cell organization, bacterial growth and control, bacterial systematic and classification of viruses.

UNIT I CELL ORGANIZATION 6

Cell size, shape and arrangements, capsule, flagella and pili, Composition and detailed structure of gram- positive and gram- negative cell wall and archaeal cell wall structure.

UNIT II BACTERIAL GROWTH AND CONTROL 6

Culture media: Components of media, Synthetic or defined media, Complex media, enriched media, selective media, differential media, enrichment culture media. Pure culture isolation: Streaking, serial dilution and plating methods.

UNIT III BACTERIAL SYSTEMATICS AND TAXONOMY 6

Taxonomy, nomenclature, systematics, types of classifications. Morphology, ecological significance and economic importance of the following groups: Archaea: methanogens, thermophiles and halophiles.

UNIT IV INTRODUCTION TO VIRUSES 6

Properties of viruses; general nature and important features. Subviral particles; viroids, prions and their importance. Isolation and cultivation of viruses.

UNIT V STRUCTURE OF VIRUSES 6

Description of important viruses: salient features of the viruses infecting different hosts - Bacteriophages (T4 & Lambda); Plant (TMV & Cauliflower Mosaic Virus), Human (HIV & Hepatitis viruses).

Total: 30 Lecture Hours

Course Outcome

At the end of the course, learners will be able to:

CO1: Get a wide knowledge on cell structure.

CO2: Have a wide knowledge on cultivation of microorganisms.

CO3: Gain a deep knowledge on taxonomy and types of classification systems.

CO4: Knowledge of properties of viruses.

CO5: Learn the details of viral structure.

TEXTBOOK:

Ananthnarayanan. R & C. K. Jeyaram Panicker; TEXTBOOKS of Microbiology, Orient Longman. 2010.

REFERENCE BOOKS:

1. Atlas RM., Principles of Microbiology. WM.T.Brown Publishers. 2nd edition.1997.

2. Madigan MT, Martinko JM, Dunlap PV and Clark DP, Brock Biology of Microorganisms. Pearson Education, Inc. 14th edition. 2014.

3. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. General Microbiology. McMillan, 5th edition. 2005.

4. Carter J and Saunders V, Virology; Principles and Applications. John Wiley and Sons. 2007.

5. Flint SJ, Enquist, LW, Krug, RM, Racaniello, VR Skalka, AM, Principles of Virology,Molecular Biology, Pathogenesis and Control. ASM Press. 2nd ed. 2004

6. Shors Teri, Understanding Viruses; Jones and Bartlett Learning Burlington USA. 2nd edition, 2013.

7. Pelczar Jr MJ, Chan ECS, and Krieg NR., Microbiology. Tata McGraw Hill. 5th edition, 2004.

8. Tortora GJ, Funke BR, and Case CL., Microbiology: An Introduction.Pearson Education. 9th edition, 2008.

9. Willey JM, Sherwood LM, and Woolverton CJ., Prescott's Microbiology. McGraw Hill Higher Education. 9th edition. 2013.

10. Dimmock, NJ, Easton, AL, Leppard, KN, Introduction to Modern Virology. Blackwell Publishing Ltd. 6th edition, 2007.

11. Cann AJ, Principles of Molecular Virology, Academic Press Oxford UK. 2012.

21PGECXX GE4: Microbial Metabolism (Theory) 4 0 0 4

Course Objectives: The candidates will understand the microbial growth, nutrient uptake and transport, chemoheterotrophic metabolism, anaerobic respiration and fermentation, chemolithotrophic and phototrophic metabolism.

UNIT I MICROBIAL GROWTH 12

Definitions of growth, Batch culture, Continuous culture, generation time and specific growth rate. Temperature and temperature ranges of growth - pH and pH ranges of growth; Effect of solute and water activity on growth; Effect of oxygen concentration on growth. Nutritional categories of microorganisms

UNIT II NUTRIENT UPTAKE AND TRANSPORT 12

Passive and facilitated diffusion; Primary and secondary active transport, concept of uniport, symport and antiport; Group translocation; Iron uptake

UNIT III CHEMOHETEROTROPHIC METABOLISM 12

Concept of aerobic respiration, anaerobic respiration and fermentation. Sugar degradation pathways i.e. EMP, ED, Pentose phosphate pathway, TCA cycle

UNIT IV ANAEROBIC RESPIRATION AND FERMENTATION 12

Anaerobic respiration,-Denitrification; nitrate /nitrite and nitrate/ammonia respiration; fermentative nitrate reduction). Fermentation - Alcohol fermentation and Pasteur effect; Lactate fermentation (homofermentative and heterofermentative pathways), concept of linear and branched fermentation pathways.

UNIT V CHEMOLITHOTROPHIC AND PHOTOTROPHIC METABOLISM 12

Introduction to aerobic and anaerobic chemolithotrophy with an example each. Hydrogen oxidation (definition and reaction) and methanogenesis (definition and reaction). Introduction to phototrophic metabolism - groups of phototrophic microorganisms, anoxygenic *vs.* oxygenic photosynthesis with reference to photosynthesis in green bacteria and Cyanobacteria.

Introduction to biological nitrogen fixation - Ammonia assimilation; Assimilatory nitrate reduction.

Total: 60 Lecture Hours

Course Outcome

At the end of the course, learners will be able to:

CO1: Compile the growth requirements of microbes.

CO2: Summarize the various nutritional uptake and transport mechanism.

CO3: Discriminate the types of metabolism, respiration and fermentation.

CO4: Classify phototrophs

CO5: Differentiate lithotrophy

TEXTBOOK:

Ananthnarayanan. R & C. K. Jeyaram Panicker; TEXTBOOKS of Microbiology, Orient Longman. 2010.

REFERENCE BOOKS:

1. Madigan MT, and Martinko JM, Brock Biology of Microorganisms. Prentice Hall International Inc.14th edition. 2014.
2. Moat AG and Foster JW., Microbial Physiology. John Wiley & Sons. 4th edition.2002.
3. Reddy SR and Reddy SM., Microbial Physiology. Scientific Publishers India. 2005.
4. Gottschalk G., Bacterial Metabolism. Springer Verlag. 2nd edition. 1986.
5. Stanier RY, Ingrahm JI, Wheelis ML and Painter PR., General Microbiology. McMillan Press. 5th edition, 1987.
6. Willey JM, Sherwood LM, and Woolverton CJ., Prescott's Microbiology. McGraw Hill Higher Education. 9th edition. 2013.

21PGECXX GE5: Industrial and Food Microbiology (Theory) 2 0 0 2

Course Objectives: The candidates will understand the development of food microbiology, microbial fermentation processes, food preservation and food-borne diseases.

UNIT I INTRODUCTION 6

Brief history and developments in industrial microbiology. Types of fermentation processes - solid state, liquid state, batch, fed-batch and continuous. Types of fermenters – laboratory, pilot-scale and production fermenters.

UNIT II MICROBIAL FERMENTATION PROCESSES 6

Ingredients used in fermentation medium - molasses, corn steep liquor, whey & Yeast extract. Downstream processing - filtration, centrifugation, cell disruption, solvent extraction. Microbial production of industrial products - citric acid, ethanol and penicillin. Industrial production and uses of the enzymes - amylases, proteases, lipases and cellulases

UNIT III FOOD AS A SUBSTRATE FOR MICROBIAL GROWTH 6

Intrinsic and extrinsic parameters that affect microbial growth in food. Microbial spoilage of food – seafoods, fruits and vegetables, milk, egg, bread and canned foods

UNIT IV PRINCIPLES AND METHODS OF FOOD PRESERVATION 6

Physical methods - high temperature, low temperature, irradiation, aseptic packaging.
Chemical methods - salt, sugar, benzoates, citric acid, ethylene oxide, nitrate and nitrite. Food sanitation and control – HACCP

UNIT V DAIRY PRODUCTS, PROBIOTICS AND FOOD-BORNE DISEASES 6

Fermented dairy products - yogurt, acidophilus milk, kefir, dahi and cheese. Probiotics definition, examples and benefits Food intoxication by *Clostridium botulinum* and *Staphylococcus aureus,* Food infection by *Salmonella* and *E.coli.*

Total: 30 Lecture Hours

Course Outcome

At the end of the course, learners will be able to:

CO1: Explain the importance of microbes in the production of many useful products

CO2: Explain fermenters and fermentation processes.

CO3: Discuss downstream processing and industrial production of various products.

CO4: Relate foods and microbes and its impact on human health

CO5: Summarize the microbial production of foods and food sanitation

TEXTBOOK:

Frazier WC and Westhoff DC., Food Microbiology. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India. 3rd edition. 1992.

REFERENCE BOOKS:

1. Crueger W and Crueger A., Biotechnology: A TEXTBOOKS of Industrial Microbiology. Panima Publishing Company, New Delhi. 2nd Edition. 2000.
2. Patel AH., Industrial Microbiology . MacMillan India Limited Publishing Company Ltd. New Delhi, India. 1996.
3. Tortora GJ, Funke BR, and Case CL., Microbiology: An introduction. Pearson Education. 9th Edition. 2008.
4. Willey JM, Sherwood LM AND Woolverton CJ, Prescott, Harley and Klein's Microbiology. McGraw Hill Higher education. 9th Edition. 2013.
5. Casida LE., Industrial Microbiology. Wiley Eastern Limited. 1991.
6. Stanbury PF, Whitaker A and Hall SJ., Principles of Fermentation Technology. Elsevier Science Ltd. 2nd edition, 2006.
7. Adams MR and Moss MO., Food Microbiology; New Age International (P) Limited Publishers, New Delhi, India. . 4th edition, 1995.
8. Banwart JM. Basic Food Microbiology. CBS Publishers and Distributors, Delhi, India. 1987.
9. Jay JM, Loessner MJ and Golden DA., Modern Food Microbiology. CBS Publishers and Distributors, Delhi, India. 7th edition, 2005.

21PGECXX GE6: Microbes in Environment (Theory) 2 0 0 2

Course Objectives: The candidates will understand the microorganisms and their habitats, microbial interactions, biogeochemical cycling and waste management.

UNIT I MICROORGANISMS AND THEIR HABITATS 6

Structure and function of ecosystems. Terrestrial Environment: Soil profile and soil microflora. Aquatic Environment: Microflora of fresh water and marine habitats. Atmosphere: Aeromicroflora and dispersal of microbes.

UNIT II MICROBIAL INTERACTIONS 6

Microbe interactions: Mutualism, synergism, commensalism, competition, amensalism, parasitism, predation. Microbe-Plant interaction: Symbiotic and non symbiotic interactions. Microbe-animal interaction: Microbes in ruminants, nematophagus fungi and symbiotic luminescent bacteria.

UNIT III BIOGEOCHEMICAL CYCLING 6

Carbon cycle: Microbial degradation of cellulose, hemicelluloses, lignin and chitin

Nitrogen cycle: Nitrogen fixation, ammonification, nitrification, denitrification and nitrate reduction. Phosphorus cycle: Phosphate immobilization and solubilisation

Sulphur cycle: Microbes involved in sulphur cycle. Other elemental cycles: Iron and manganese.

UNIT IV WASTE MANAGEMENT 6

Solid Waste management: Sources and types of solid waste, Methods of solid waste disposal (composting and sanitary landfill). Liquid waste management: Composition and strength of sewage (BOD and COD).

UNIT V MICROBIAL BIOREMEDIATION 6

Principles and degradation of common pesticides, hydrocarbons (oil spills). Treatment and safety of drinking (potable) water, methods to detect potability of water samples: (a) standard qualitative procedure: presumptive test/MPN test, confirmed and completed tests for faecal coliforms (b) Membrane filter technique and (c) Presence/absence tests.

Total: 45 Lecture Hours

Course Outcome

At the end of the course, learners will be able to:

CO1: To formulate the structure and functions of ecosystem and role of microbes in the environment.

CO2: To create and obtain knowledge about microbial interactions – symbiosis, antagonism, synergism, commensalism, amensalism, parasitism, and predation.

CO3: To develop importance of biogeochemical cycling in the ecosystems.

CO4: To evaluate and obtain knowledge on microbiological aspects and management of waste water.

CO5: To evaluate the microbial bioremediation of pesticides, hydrocarbons, oil spills.

TEXTBOOK:

Pradipta.K.M., TEXTBOOK of Environmental Microbiology; I.K.Publishing House; 2008.

REFERENCE BOOKS:

1. Atlas RM and Bartha R. Microbial Ecology: Fundamentals & Applications. Benjamin/Cummings Science Publishing, USA. 4th edition. 2000.
2. Madigan MT, Martinko JM and Parker J. Brock Biology of Microorganisms. Pearson/ Benjamin Cummings. 14th edition. 2014.
3. Maier RM, Pepper IL and Gerba CP., Environmental Microbiology. Academic Press. 2nd edition, 2009.
4. Okafor, N, Environmental Microbiology of Aquatic & Waste systems. Springer, New York. 2011.
5. Singh A, Kuhad, RC & Ward OP, Advances in Applied Bioremediation. Volume 17, Springer-Verlag, Berlin Hedeilberg. 2009.
6. Barton LL & Northup DE, Microbial Ecology. Wiley Blackwell, USA2011.

21PGECXX GE7: Medical Microbiology and Immunology (Theory) 2 0 0 2

Course Objectives: The candidates will understand the concepts of normal flora organisms microbial diseases, antimicrobial agents and immune cells, and immune response and immunological disorders.

UNIT I NORMAL MICROFLORA AND SAMPLE COLLECTION 6

Normal microflora of the human body: Importance of normal microflora, normal microflora of skin, throat, gastrointestinal tract, urogenital tract. Host pathogen interaction: Definitions - Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity.

UNIT II MICROBIAL DISEASES 6

List of diseases of various organ systems and their causative agents. List of diseases of various organ systems and their causative agents. List of diseases of various organ systems and their causative agents. Brief description of various types of mycoses.

UNIT III ANTIMICROBIAL AGENTS AND IMMUNE CELLS 6

Antibacterial agents: Five modes of action with one example each: Inhibitor of nucleic acid synthesis; Inhibitor of cell wall synthesis; Inhibitor of cell membrane function; Inhibitor of protein synthesis; Inhibitor of metabolism Antifungal agents: Structure, Functions and Properties of: Immune Cells – Stem cell, T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell, Dendritic cell.

UNIT IV IMMUNE ORGANS, ANTIGENS AND ANTIBODIES 6

Immune Organs – Bone; Marrow, Thymus, Lymph Node, Spleen. Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity); Haptens; Epitopes (T & B cell epitopes), Adjuvants, Structure, Types and Functions of antibodies.

UNIT V IMMUNE RESPONSE DISORDERS 6

Primary and Secondary Immune Response; Generation of Humoral Immune Response (Plasma and Memory cells); Generation of Cell Mediated Immune Response. Types of Autoimmunity

and Hypersensitivity with examples; Immunodeficiencies - Animal models (Nude and SCID mice). Principles of Precipitation, Agglutination, Immunodiffusion, Immunoelectrophoresis, ELISA, ELISPOT.

Total: 30 Lecture Hours

Course Outcome

At the end of the course, learners will be able to:

CO1: Appraise the importance of normal microbial flora in human health and host pathogen interactions.

CO2: Perceive knowledge on microbial diseases affecting various organ systems.

CO3: Classify antibiotics based on their mode of action.

CO4: Discuss the role of immune cells and organs in developing immunity against microbial diseases.

CO5: Summarize the importance of immunological disorders.

TEXTBOOK:

Ananthanarayan R. and Paniker C.K.J. Textbooks of Microbiology. University Press Publication. 8th edition, 2009.

REFERENCE BOOKS:

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

2. Goering R., Dockrell H., Zuckerman M. and Wakelin D., Mims' Medical Microbiology. Elsevier. 4th edition., 2007.

21PGECXX GE8: Genetic Engineering and Biotechnology (Theory) 2 0 0 2

Course Objectives: The candidates will understand the development genetic engineering, vectors, DNA amplification and DNA sequencing, application of genetic engineering and biotechnology.

UNIT I INTRODUCTION TO GENETIC ENGINEERING 6

Milestones in genetic engineering and biotechnology. Restriction modification systems: Mode of action, applications of Type II restriction enzymes in genetic engineering. DNA modifying enzymes and their applications: DNA polymerases.

UNIT II VECTORS 6

Cloning Vectors: Definition and Properties - Plasmid vectors: pBR and pUC series, Bacteriophage lambda and M13 based vectors, Cosmids, BACs, YACs. Expression vectors: *E.coli* lac and T7 promoter-based vectors, yeast YIp, YEp and YCp vectors, Baculovirus based vectors, mammalian SV40-based expression vectors.

UNIT III DNA AMPLIFICATION AND DNA SEQUENCING 6

PCR: Basics of PCR, RT-PCR, Real-Time PCR, Genomic and cDNA libraries: Preparation and uses, Genome sequencing - Sanger's method of DNA Sequencing: traditional and automated sequencing

UNIT IV APPLICATION OF GENETIC ENGINEERING 8

Gene delivery: Microinjection, electroporation, biolistic method (gene gun), liposome and viral mediated delivery, *Agrobacterium* - mediated delivery. Products of recombinant DNA technology: Products of human therapeutic interest - insulin, hGH, antisense molecules. Bt transgenic - cotton, brinjal, flavo savo tomato, Gene therapy, recombinant vaccine, protein engineering

UNIT V INTELLECTUAL PROPERTY RIGHTS 4

Patents, Copyrights, Trademarks.

Total: 30 Lecture hours

Course Outcome

At the end of the course, learners will be able to:

CO1: Write about the genetic engineering and enzymology.
CO2: Construct the cloning vectors used in genetic engineering.
CO3: Analyze DNA amplification and sequencing methods.
CO4: Explain gene transfer methods in genetic engineering.
CO5: Interpret the intellectual property rights, patent, copyrights and. Trademarks.

TEXTBOOK:

Primrose SB and Twyman RM. Genomics: Applications in human biology. Blackwell Publishing, Oxford, U.K. 2008.

REFERENCE BOOKS:

1. Brown TA., Gene Cloning and DNA AnalysisBlackwell Publishing, Oxford, U.K. 6th edition. 2010.
2. Clark DP and Pasternik NJ. Biotechnology: Applying the Genetic Revolution. Elsevier Academic Press, USA. 2009.
3. Primrose SB and Twyman RM., Principles of Gene Manipulation and Genomics, Blackwell Publishing, Oxford, U.K. 7th edition. 2006.
4. Brown TA., Genomes-3. Garland Science Publishers. 2007.

Teaching-learning processes:

The teaching learning processes incorporate a variety of modes and a regular use of ICT. These are listed below:

1. **Classroom Teaching** for topics which are intensely information-based. This a very regular feature of all the courses in Microbiology

2. **Power Point slides** for topics which involve information related to intricate biological pathways such as metabolic pathways in bacteria and other microorganisms.Use of Power Point presentations are also made whenever the lectures are to be summarized in a crisp and pointwise manner to highlight salient / important conclusions from the topics.

3. **Classroom Discussions** are a regular feature while teaching. The students are drawn into impromptu discussions by the teacher during the process of teaching.

4. **Video Displaying**, both real-time and animations, are used for topics which require 3D dimensional viewing of the biological mechanisms to drive the point home. These have proved to be very helpful while teaching concepts of molecular biology like DNA replication, transcription and translation. These are also used to convey complexities of antigen-antibody interactions and generation of antibody diversity during the teaching of Immunology.

5. **Model Making** is also used especially for understanding and building a perception of the students for the structures of viruses which cannot be seen by a light microscope and can be seen only under expensive equipment like electron microscopes.

6. **Laboratory Practical** are an integral part of every course included in UG programme in Microbiology. The is also a daily affair for UG students of Microbiology.

7. **Problem Solving** is encouraged during the laboratory work.

8. **Group Activity** as well as discussions with the laboratory supervisor/ among the students themselves/ Mentor is also encouraged during laboratory work.

9. **Project Work** is included in the programme where students work individually or in groups to design experiments to solve/answer a problem suggested by the Mentor or identified by the students in consultation with the Mentor. The students are mentored regularly during the duration the project is in progress.

10. **Presentations by the Students** are regularly done. The students are mentored in presentation of data, interpretation of data and articulation with the students/teachers/Research Scholars during their presentation.

11. **Presentation by Experts** in different specialties of Microbiology are arranged to broaden the horizons of the students.

12. **Interaction with Experts** is also encouraged during/after presentations to satisfy/ignite curiosities of the students related to developments in the different ares of Microbiology.

13. **Visit to Industries/Laboratories** related to Microbiology like fermentation, food, diagnostics etc. are organized to acquaint the students with real-life working environments of the professional microbiologists with a view to broaden their perspective of the subject of Microbiology.

Assessment Tasks:

It is important that the students of UG Microbiology program achieve the desired results in terms of the learning outcomes to be professionally sound and competitive in a global society. Achieving the desired learning outcomes is also imperative in terms of job employment leading to a happy and prosperous individual further leading to a happy and prosperous family and thereby a happy and prosperous society or nation. The assessments tasks are pivotal to get an authentic feedback for the teaching learning process and for mid-course corrections and further improvements in future. The assessment tasks are carried out at various stages of the duration of the UG Microbiology programme like Mid-term assessments, End-term assessments, Semester examinations, Regular assessments, viva-voce etc. The assessment tasks are listed below:

1. **Multiple Choice Questions (MCQ)** are one of the predominant forms of assessment tasks. This task is used during all kinds of term and semester examinations.

2. **Short-Answer Questions** during term and semester examinations are used to assess the ability of the student to convey his thoughts in a coherent way where prioritization of the information in terms of their significance is tested.

3. **Surprise Quizzes** are regularly used during continuous assessment while the teaching learning process is continuing which prepares the student to quickly recall information or quickly analyze a problem and come up with proper solutions.

4. **Visual/Pictorial Quizzes** are used to sharpen the comprehension of the students after looking at all the components of a system.

5. **Impromptu Opinions** on microbiological problems are sought from student during regular teaching learning which help them to think quickly in a given context. This help build their ability to come up with solutions to problems which the students might not have confronted previously.

6. **Problem Solving** question are generally given during the laboratory work.

7. **Data Interpretation** is also another assessment task which is used to develop analytical skills of the students. This assessment is used during laboratory work as well as during conduction of project work.

8. **Analytical Skills** are assessed during work related to several experiments like enzyme kinetics, growth of bacteria and bacteriophages, mutation frequencies.

9. **Paper/ Project presentations** are used to assess the articulation skills of the student. These are carried out both during the duration of the teaching learning processes as well as during end-Semester examinations.

10. **Report Writing** is used to assess the keenness of the students for details related to microbiology while visiting laboratories / industries as students invariably are required to submit a report after such visits.

11. **Assignment Writing** are used to assess the writing abilities of the students during mid- term vacations.

12. **Viva-voce** during the laboratory working hours and during laboratory examination are used to assess the over-all knowledge and intelligence of the students.

Key Words:

Microbiology, Teaching, Learning outcomes, Curriculum, Curriculum Framework, Programme outcomes, Course outcomes, UG Programme, Undergraduate programme, Teaching learning processes, Assessment Tasks, Evaluation Tasks, Online Courses, MOOCS, NPTEL, SWAYAM, UGC, India, Higher Education Institutions, HE