

INSTITUTE OF SCIENCE, TECHNOLOGY & ADVANCED STUDIES (VISTAS)
(Deemed to be University Estd. u/s 3 of the UGC Act, 1956)
PALLAVARAM - CHENNAI
ACCREDITED BY NAAC WITH 'A' GRADE
Marching Beyond 30 Years Successfully
INSTITUTION WITH UGC 12B STATUS

POSTGRADUATE DEGREE PROGRAMME

M.Sc., Immunology & Microbiology

Two Years

CURRICULUM & SYLLABUS

REGULATION 2024

Choice Based Credit System (CBCS)

&

Learning Outcomes Based Curriculum Framework (LOCF)

Effective from the Academic Year

2024 -2025

Department of Microbiology
School of Life Sciences



DEPARTMENT OF MICROBIOLOGY

VISION OF THE DEPARTMENT
To produce graduates with relevant education descriptors and hands-on skills in microbiology and related areas of life sciences plus holistic development of individuals that makes them responsible citizens of society.

MISSION OF THE DEPARTMENT	
M1	Imparting relevant knowledge and creating an atmosphere to develop innovative and critical thinking.
M2	Skill enhancement through hands-on training and value-added courses plus add on courses.
M3	Sustained focus on original high-quality research encouraging scientific thinking and approach.
M4	Creating an environment for holistic development of individuals with emphasis on spirit of integrity, equity, professional ethics and social harmony through the exposure and participation in co-curricular, extracurricular and extension activities.

PROGRAMME EDUCATIONAL OUTCOMES (PEO)	
PEO1	To provide the candidates with in-depth knowledge in immunology and microbiology and a firm grasp of the processes that employ or deal with microbes plus adept use of immunological techniques in relevant technologies that empowers them to deal with the safe and efficient use and monitoring of microbiological and immunological applications with development of competence on par with global standards and helps in the life-long learning of candidates.
PEO2	To enable candidates by imparting updated analytical and hands-on skills to use and implement technological developments related to advanced and potential areas involving molecular diagnostics, automated systems of diagnosis, immunoblotting technology, upstream or downstream processing and nanotechnology with scope for upskilling upto future technologies so as to contribute effectively for Research & Development leading to patenting and publishing.
PEO3	To train candidates to choose a decent career option either as Entrepreneur or having a high degree of employability; or pursue research – by providing training in interpersonal skills, sense of social responsibility, ethical and administrative acumen, ability to handle critical situations allowing them to be good team members and leaders as well as training to excel in competitive examinations.
PEO4	To impart a strong sense of social responsibility with awareness of professional and societal ethical values and scope to develop leadership capabilities with the continuous need for lifelong learning.

PROGRAMME OUTCOMES (PO)	
PO1	Life Sciences knowledge: Successful candidates will apply current/recent specific knowledge in the respective discipline with proficiency in practical skills and leadership skills for a successful career.
PO2	Problem analysis: Successful candidates will be able to apply the knowledge in microbiology to design standards, resolve and troubleshoot problems in

	implementation or standardization of protocols.
PO3	Design/development of solutions: Successful candidates will develop creative and cognitive thinking and cooperate with each other to solve problems in the field of Life sciences.
PO4	Conduct investigations of complex problems: Successful candidates will acquire capabilities to plan and design protocols and utilize practical skills to validate hypothesis by executing experimental techniques independently coupled with the ability to assimilate, apply, analyze, interpret and accurately evaluate subsequent data.
PO5	Modern tool usage: Successful candidates will effectively be able to choose and manage resources including time using ICT and other computer enabled devices.
PO6	Ethics: Successful candidates will be aware of their role and responsibility in proper handling, use and safe disposal of microbes including genetically modified microorganisms.
PO7	Communication: Successful candidates will have the ability to understand and communicate all ideas and concepts effectively.
PO8	Environment sustainability: Successful candidates will get adequate knowledge to use information and implement solutions for environmental protection, safeguards and remediation.
PO9	Lifelong learning: Successful candidates will carry on to learn, adapt and disseminate knowledge in a world of constantly evolving technology.

PROGRAMME SPECIFIC OUTCOMES (PSO)	
PSO1	The ability to understand, implement and troubleshoot the concepts related to the fields of microbiology and immunology which will enable them to analyse and develop solutions to microbiology, immunology and rDNA related problems using knowledge and hands-on skills in microbiology, molecular identification, immunodiagnostics, screening for useful biomolecules and nanotechnology in the interpretation of data in relevant protocols.
PSO2	The ability to gainfully become an entrepreneur by using microorganisms to mass produce biofertilizers, mushrooms or any other edible forms of SCP, fermented products and pharmaceutically important biomolecules as well as using knowledge, communication and practical hands-on training to become employed in diagnostic, industrial, pharmaceutical, food and research and development laboratories.
PSO3	The ability to understand the principles and concepts underlying immunology and microbiology, including the interactions between microorganisms and the immune system and to Possess proficient laboratory skills in techniques relevant to immunology and microbiology, including culturing microorganisms, performing immunological assays, and molecular biology techniques such as PCR and sequencing etc.,
PSO4	The ability to critically analyze the research in Immunology and Microbiology and to evaluate experimental design, methodology and interpretation of results and to understand the regulation of immune responses which includes the roles of different immune cells, cytokines and signaling pathways in health and disease.
PSO5	For the effective scientific communication and to relate microbes and their role in ecosystem and public health research with wide opportunities and career prospects.

BOARD OF STUDIES

List of Members

Department of Microbiology

S. No	Name & Designation	Address	Role
1	**Dr.G.Gayathri** Professor and Head Department of Microbiology, VISTAS. Chennai.	Professor and Head Department of Microbiology, VISTAS. Chennai.	**Chairperson**
2	**Dr. A.K.Kathireshan** Professor & Director, School of Life Sciences, VISTAS, Chennai.	Professor & Director School of Life Sciences, VISTAS. Chennai.	**Member**
3	**Dr.Suresh Dhanaraj** Professor Department of Microbiology, VISTAS. Chennai.	Professor Department of Microbiology, VISTAS. Chennai.	**Member**
4	**Dr.S.B.Prabha** Assistant Professor Department of Microbiology, VISTAS. Chennai.	Assistant Professor Department of Microbiology, VISTAS. Chennai.	**Member**
5	**Dr.S.V.Rajyoganandh** Assistant Professor Department of Microbiology, VISTAS. Chennai.	Assistant Professor Department of Microbiology, VISTAS. Chennai.	**Member**
6	**Dr. K.Mahalakshmi** Professor and Head	Director – Research lab for Oral and Systemic Health, Department of Microbiology, Sree Balaji Dental College and Hospital, Pallikaranai, Bharath University, Chennai.	**Academic Expert (External Member)**
7	**Dr.Babu Sarangan** Managing Director, Mahathi Biotech.	Mahathi Biotech K.K Nagar, Chennai – 78.	**Industrial Expert (External Member)**
8	**Thiru Siraj Kareem** Managing Director Inlead Management	Inlead Management Services, Mangadu, Chennai.	**Alumini (External Member)**

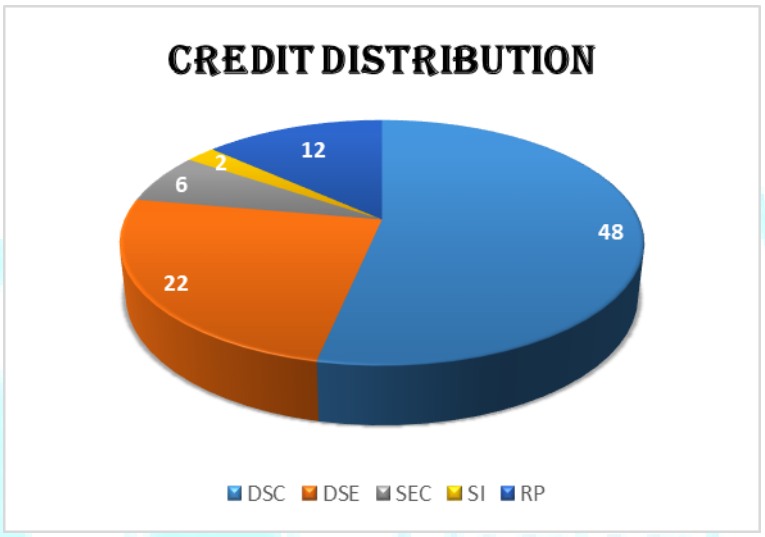
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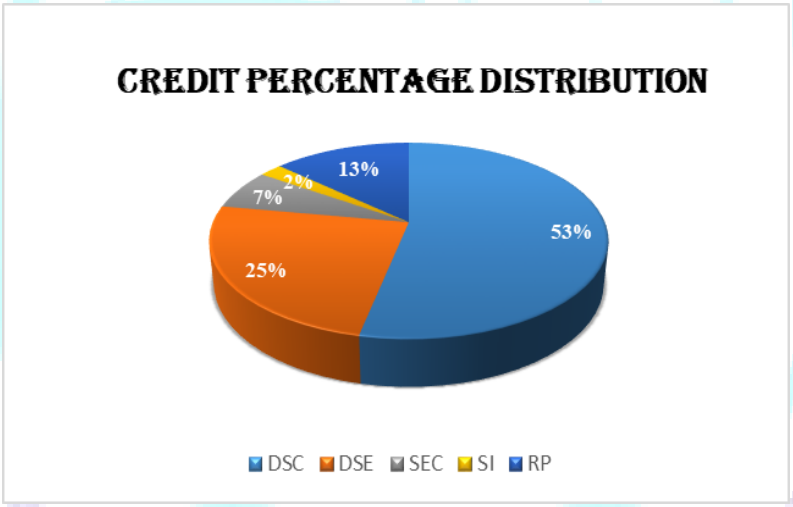
M.Sc., Immunology & Microbiology
Minimum credits to be earned: 90

Component	I Sem	II Sem	III Sem	IV Sem	2 Yrs Total Credits
DSC	14	16	14	4	48
DSE	8	4	6	4	22
SEC	2	2	2	-	6
SI	-	2	-	-	2
RP	-	-	-	12	12
Total Credits	24	24	22	20	90

ABBREVIATIONS

DSC	Discipline Specific Core
DSE	Discipline Specific Elective
SEC	Skill Enhancement Course
SI	Summer Internship
RP	Research Project


CREDIT DISTRIBUTION
12
2
6
48
22
DSC
DSE
SEC
SI
RP


CREDIT PERCENTAGE DISTRIBUTION
13%
2%
7%
53%
25%
DSC
DSE
SEC
SI
RP

CURRICULUM STURCTURE
M.Sc., Immunology & Microbiology

Total number of Credits: 90

M.Sc., Immunology & Microbiology Minimum Credits to be earned :90

SEMESTER 1

			Hours/Week					Maximum Marks		
Category	**Code**	**Course**	**L**	**T**	**P**	**O**	**C**	**CIA**	**SEE**	**Total**
DSC 1	24CMIM11	Immunology	4	0	0	2	4	40	60	100
DSC 2	24CMIM12	General Microbiology	4	0	0	2	4	40	60	100
DSC 3	24CMIM13	Food Microbiology	4	0	0	2	4	40	60	100
DSC 4 (Lab)	24PMIM11	Practical - I – Practical in General Microbiology and Food Microbiology	0	0	4	1	2	40	60	100
DSE 1	24DMIM11	Discipline Specific Elective I	4	0	0	2	4	40	60	100
DSE 2	24DMIM13	Discipline Specific Elective II	4	0	0	2	4	40	60	100
SEC 1	24SSKP11	Soft Skill I/Sector Skill Course	2	0	0	1	2	40	60	100
			22	**-**	**4**		**24**	**-**	**-**	**-**

CIA - Continuous Internal Assessment **SEE - Semester End Examination**

***L – Lecture, *T- Tutorial, *P- Practical, *O - Outside the class effort / self-study, *C - Credits**

SEMESTER 2

Category	**Code**	**Course**	**L**	**T**	**P**	**O**	**C**	**CIA**	**SEE**	**Total**
DSC 5	24CMIM21	Cell Culture and Fermentation Technology	4	0	0	2	4	40	60	100
DSC 6	24CMIM22	Molecular Immunology and Immunogenetics	4	0	0	2	4	40	60	100
DSC 7	24CMIM23	Medical Bacteriology	4	0	0	2	4	40	60	100
DSC 8 (Lab)	24PMIM21	Practical –II - Practical in Immunology and Bacteriology	0	0	4	1	2	40	60	100
DSC 9 (Lab)	24PMIM22	Practical –III - Practical in Molecular biology	0	0	4	1	2	40	60	100
DSE 3	24DMIM21	Discipline Specific Elective III	4	0	0	2	4	40	60	100
SI	24INPG21	Internship	0	0	2	1	2	40	60	100
SEC 2	24SSKP12	Soft Skill II/Sector Skill Course	2	0	0	1	2	40	60	100
			18	**-**	**10**		**24**	**-**	**-**	**-**

CIA - Continuous Internal Assessment SEE - Semester End Examination

***L – Lecture, *T- Tutorial, *P- Practical, *O - Outside the class effort / self-study, *C - Credits**

SEMESTER 3										
Category	**Code**	**Course**	**L**	**T**	**P**	**O**	**C**	**CIA**	**SEE**	**Total**
DSC 10	24CMIM31	Clinical Immunology and Vaccinology	4	0	0	2	4	40	60	100
DSC 11	24CMIM32	Medical Virology	4	0	0	2	4	40	60	100
DSC 12	24CMIM33	Immunotechnology	4	0	0	2	4	40	60	100
DSC 13 (Lab)	24PMIM31	Practical – Clinical Immunology and Immunotechnology	0	0	4	1	2	40	60	100
DSE 4	24DMIM31	Discipline Specific Elective IV	3	0	0	2	3	40	60	100
DSE 5	24DMIM33	Discipline Specific Elective V	3	0	0	2	3	40	60	100
SEC 3	24SSKP13	Soft Skill III/Sector Skill Course	2	0	0	1	2	40	60	100
			20	-	**4**		**22**	**-**	**-**	**-**

CIA - Continuous Internal Assessment SEE - Semester End Examination

***L – Lecture, *T- Tutorial, *P- Practical, *O - Outside the class effort / self-study, *C - Credits**

SEMESTER 4										
Category	**Code**	**Course**	**L**	**T**	**P**	**O**	**C**	**CIA**	**SEE**	**Total**
DSE 6	24DMIM41	Discipline Specific Elective VI	3	0	0	2	3	40	60	100
DSC 14	24CMIM41	Environmental Microbiology	4	0	0	2	4	40	60	100
DSC 15	24PMIM41	Practical V – Environmental Microbiology	0	0	3	1	1	40	60	100
RP 1	24RMIM41	Research Project	0	0	12	10	12	40	60	100
			7	**-**	**15**		**20**	**-**	**-**	**-**

CIA - Continuous Internal Assessment SEE - Semester End Examination

***L – Lecture, *T- Tutorial, *P- Practical, *O - Outside the class effort / self-study, *C - Credits**

DISCIPLINE SPECIFIC CORE COURSES

Category	Code	Course	L	T	P	O	C
DSC 1	24CMIM11	Basic Concepts in Immunology	4	0	0	2	4
DSC 2	24CMIM12	General Microbiology	4	0	0	2	4
DSC 3	24CMIM13	Food Microbiology	4	0	0	2	4
DSC 4 (Lab)	24PMIM11	Practical - I – Practical in General Microbiology and Food Microbiology	0	0	4	1	2
DSC 5	24CMIM21	Cell Culture and Fermentation Technology	4	0	0	2	4
DSC 6	24CMIM22	Molecular Immunology and Immunogenetics	4	0	0	2	4
DSC 7	24CMIM23	Medical Bacteriology	4	0	0	2	4
DSC 8 (Lab)	24PMIM21	Practical –II - Practical in Immunology and Bacteriology	0	0	4	1	2
DSC 9 (Lab)	24PMIM22	Practical –III - Practical in Molecular biology	0	0	4	1	2
DSC 10	24CMIM31	Clinical Immunology and Vaccinology	4	0	0	2	4
DSC 11	24CMIM32	Medical Virology	4	0	0	2	4
DSC 12	24CMIM33	Immunotechnology	4	0	0	2	4
DSC 13 (Lab)	24PMIM31	Practical – Clinical Immunology and Immunotechnology	0	0	4	1	2
DSC 14	24CMIM41	Environmental Microbiology	4	0	0	2	4

DISCIPLINE SPECIFIC ELECTIVE COURSES

Category	Code	Course	L	T	P	O	C
DSE 1	24DMIM11	Microbial Physiology	4	0	0	2	4
	24DMIM12	Biosafety and Intellectual Property Rights (IPR)	4	0	0	2	4
DSE 2	24DMIM13	Biochemical Techniques and Instrumentation	4	0	0	2	4
	24DMIM14	Antimicrobial Agents and Resistance	4	0	0	2	4
DSE 3	24DMIM21	Microbial Genetics and Molecular biology	4	0	0	2	4
	24DMIM22	Cloning strategies and Nanotechnology	4	0	0	2	4
DSE 4	24DMIM31	Medical Mycology and Parasitology	3	0	0	2	3
	24DMIM32	Bioinformatics in Microbiology	3	0	0	2	3
DSE 5	24DMIM33	Recombinant DNA Technology	3	0	0	2	3
	24DMIM34	Medical Biotechnology	3	0	0	2	3
DSE 6	24DMIM41	Cyber Security	3	0	0	2	3
	24DMIM42	Microbial Technology for Human Welfare	4	0	0	2	4
	24DMIM43	Bioenergetics in Microorganisms	4	0	0	2	4

SKILL ENHANCEMENT COURSES

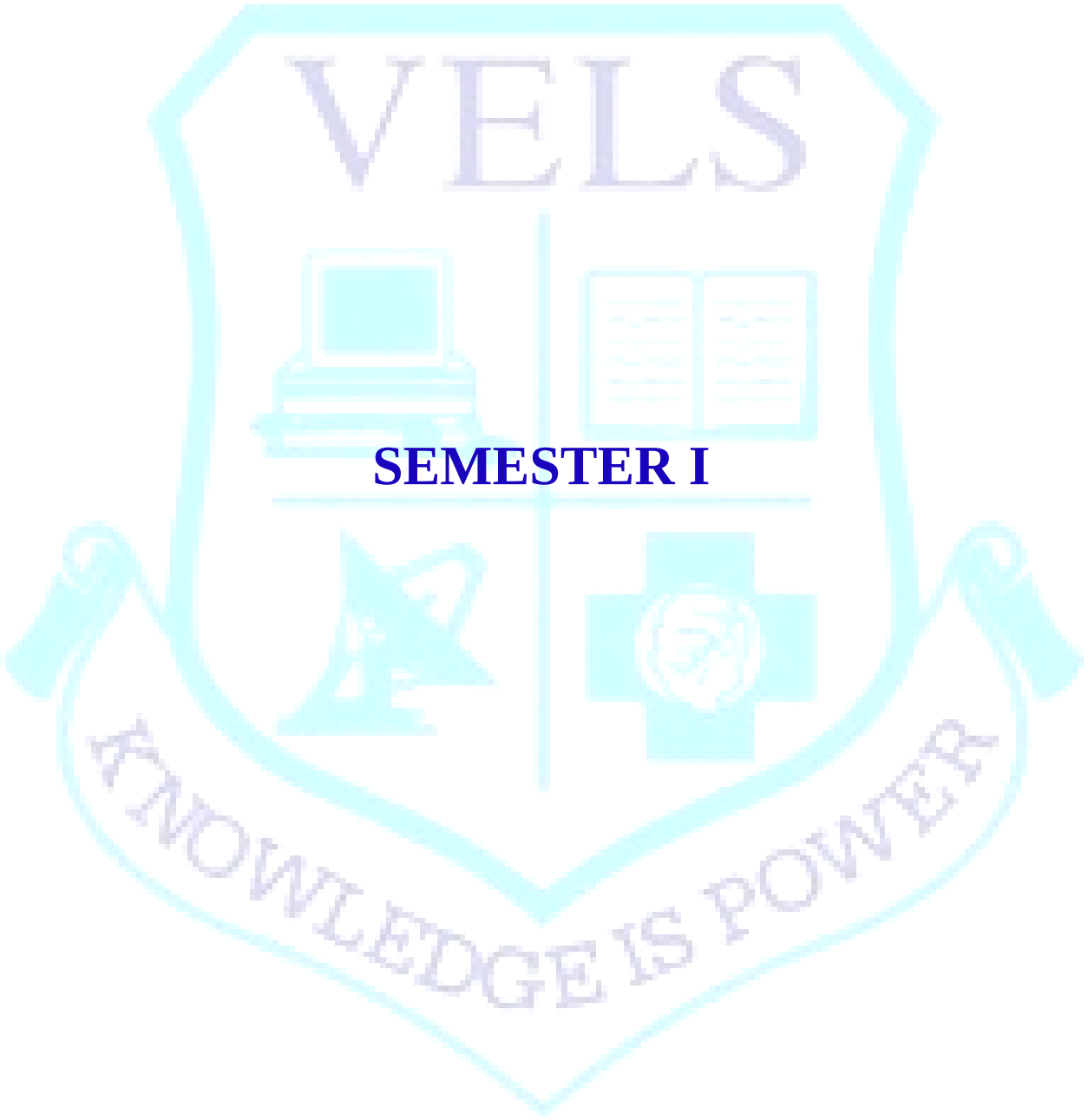
Category	Code	Course	L	T	P	O	C
SEC 1	24SSKP11	Soft Skills I	2	0	0	1	2
SEC 2	24SSKP12	Soft Skills II	2	0	0	1	2
SEC 3	24SSKP13	Soft Skills III	2	0	0	1	2

SUMMER INTERNSHIP

Category	Code	Course	L	T	P	O	C
SI	24INPG21	Internship	0	0	2	1	2

RESEARCH PROJECT

Category	Code	Course	L	T	P	O	C
RP 1	24RMIM41	Research Project I	0	0	12	10	12



SEMESTER I

24CMIM11 **IMMUNOLOGY**

L	T	P	O	C
4	0	0	2	4

COURSE OBJECTIVE:

The course gives the students an understanding of how the immune system orchestrates against the process of infection and disease. The students will also gain insights on antibodies and immunoglobulins and other mediators at molecular level. The students will develop an appreciation of how the immune mechanisms can overreact. The course gives a detailed insights on vaccines with latest advances in vaccine development.

UNIT- I EVOLUTIONARY IMMUNOLOGY 12

Introduction to evolutionary immunology. Immunity- types-innate and adaptive. Cell mediated immunity and Humoral immunity. Primary and Secondary lymphoid organs, lymphoid tissues. Immunoreactive cells- structure and functions- macrophages, granulocytes, NK cells, dendritic cells, lymphocytes and subsets. Phagocytosis.

UNIT-II DEVELOPMENTAL IMMUNOLOGY 12

Ontogeny and phylogeny of lymphocytes, B-cell receptors; Thymic selection of T-cells; Activation and function of T and B cells. Cytokines – General properties, functional categories

UNIT-III ANTIGENS AND IMMUNOGLOBULINS 12

Antigens and immunogenicity. Terminologies and definition- antigens and epitopes - sequential and conformational epitopes, Haptens, adjuvants, superantigens, mitogens. Factors associated with antigenicity. Immunoglobulin- structure, types, distribution, biological and chemical properties. Theories of antibody production. Monoclonal and polyclonal antibodies.

UNIT – IV ANTIGEN-ANTIBODY REACTIONS 12

Antigen-antibody interactions- Primary interactions, *in vitro* reactions-precipitation, agglutination reactions, labelled assays – ELISA, RIA, and IFT. The Complement Cascade Classical, Alternate and Lectin pathways, biological functions.

UNIT– V HYPERSENSITIVITY AND VACCINES 12

Hypersensitivity Reactions– Overview, types and mechanisms. Overview of vaccines. Definitions - Passive immunization. Reverse Vaccinology. Immunotherapy- functions and applications of antibodies. Development of antibodies plants. Introduction to systems immunology.

Total: 60 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 antigens and antibodies.

CO3: Explain the principles involved in hybridoma technology.

CO4: Discuss the functioning of complement system.

CO5: Perceive the importance of cytokines in immune responses.

CO6: Analyze the outcome of overreaction by our immune system.

CO7: Explain about the recent advances in immunology such as reverse vaccinology and Systems immunology.

Text Books:

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

Reference Books:

1. Ivan M. Roitt, J. Brostoff and D. K. Male (1993), Immunology, Gower Medical Publishing, London.
2. W.R. Clark (1991), The experimental foundations of modern immunology, John Wiley and Sons Inc, New York.
3. Jenni Punt, Sharon A. Stranford, Patricia P. Jones, Judith A. Owen. Janis Kuby (2019), Kuby Immunology, 8th Edition, W. H. Freeman and Company, New York.
4. Janeway Travers (1997), Immunobiology- the immune system in health and disease, 3rd Edition, Current Biology Ltd. London, New York.
5. Peter J. Delves, Ivan M. Roitt (1998), Encyclopedia of Immunology, 2nd Edition, Academic Press.
6. H Chapel and M Halbey (1986), Essentials of Clinical Immunology, ELBS.
7. Leslie Hudson and Frank C. Hay (1989), Practical Immunology, 3rd Edition, Blackwell Scientific Publications.
8. Pravash Sen Gupta (2003), Clinical Immunology, Oxford University Press.
9. Noel R. Rose, Herman Friedman, John L. Fahey (1986), Manual of Clinical Laboratory Immunology, 3rd Edition, American Society for Microbiology.

Web Sources:

1. https://www.ncbi.nlm.nih.gov/books/NBK534246/
2. https://www.nature.com/articles/s41590-021-01058-1

24CMIM12 **GENERAL MICROBIOLOGY**

L	T	P	O	C
4	0	0	2	4

COURSE OBJECTIVE:

The candidate will gain knowledge about the structure of bacteria, fungi, algae, protozoa and viruses along with the basic principles of microscopy. Control of microbial growth by physical and chemical methods plus the use of antibiotics and their efficacy testing are emphasized. Cultivation of microbes and space microbiology is discussed.

UNIT- I INTRODUCTION 12

Historical perspective and scope of microbiology. Description of various groups of microorganisms with typical example. Cell cycle and reproduction of bacteria. Bacterial cell structure and components. Microbial classification. Tools and techniques in microbiology

UNIT-II MICROSCOPY 12

Microscopy–principles of microscopy-bright-field microscopy–Simple microscope, Compound microscope, PCM, FM, DFM,TEM,SEM and STEM–description, principle and use. Scanning Probe Microscopy (SPM), Applications of Microscopy, Preparing Samples for Microscopy, Modern Advances -Super-Resolution Microscopy, Cryo-Electron Microscopy (Cryo-EM)**).**

UNIT-III STERILIZATION 12

Sterilization– Principle, use and quality control of: High temperature -Dry Heat- Hot air oven, incineration, moist heat- Tyndallization, Pasteurization, inspissation, moist heat under pressure; low temperature–preservation; filtration-membrane filters, depth filters; centrifugation; radiation. Disinfection-Mode of action and Evaluation – RW test, KS Test, Use-Dilution method. Sterilization Validation (Biological Indicators, Chemical Indicators, Mechanical Indicators)

UNIT – IV ANTIBIOTICS 12

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. Development of New Antibiotics -Novel Antibiotics, Teixobactin, Murepavadin, Rapid Diagnostic Techniques -Point-of-Care Testing, Genomic and Proteomic Approaches, Microbiome-Based Therapies.

UNIT– V MICROBIAL GROWTH 12

Growth requirements of Bacteria. Microbial culture media and pure culture techniques. Anaerobic cultivation methods. Preservation of cultures. Quantitation of microbial growth and bacterial growth curve in batch culture. Microbial Growth in Extreme Environments - Thermophiles, Space Microbiology.

Total: 60 Hours

Course Outcome:

At the end of this course students will be able to:

CO1: Demonstrate knowledge of fundamental microbiological principles.

CO2: Evaluate the outcomes of various antibiotic sensitivity tests.

CO3: Decide the optimum media for growth of microbes.

CO4: Assess the outcome of sterilization and disinfection protocol.

CO5: Judge the suitability of microscopes to microbial cytology.

CO6: Choose appropriate methods for cultivation of microorganisms.

Text Books:

1. J. Michael , E.C.S.Chan, Noel R.Krieg (2006), Microbiology,Tata-McGrawHill.Ed.5.

Reference Books:

1. R. Ananthanarayanan & C.K.Jeyaram Paniker (2005), Textbook of Microbiology, Orient Longman.Ed.7; 2.
2. T. Michael Madigan, M. John Martinko (2006), Brock's Biology of Microorganisms, Ed.11 Pearson-Prentice Hall.
3. M. Ronald Atlas; (1997), Principles of Microbiology, Ed. 2. WCB Publishers.
4. Y. Roger L. Stanier, John L. Ingraham, Mark Page. Wheelis, R. Painter (2004), General Microbiology, Ed. 5. MacMillan Press.
5. Topley & Wilson's (2002), Principles of Bacteriology, Virology&Immunology, Ed. 9; Edward Arnold.
6. M. Lansing John Prescott, Donald Harley, A. Donald Klein (2005), Microbiology, Ed.6 McGraw Hill.

Web Sources:

3. https://www.britannica.com/science/microbiology
4. https://www.slideshare.net/slideshow/lect-1-introduction/34565343
5. https://www.slideshare.net/slideshow/introduction-to-microbiology-67925181/67925181

24CMIM13 **FOOD MICROBIOLOGY**

L	T	P	O	C
4	0	0	2	4

COURSE OBJECTIVE:

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

Food and Microorganisms- Historical developments, Microorganisms important in food molds, yeast and bacteria- general characteristics, classification and importance; Factors affecting growth of microorganisms-Hydrogen ion conc., water activity, oxidation reduction potential, nutrient content, inhibitory substances and biological structure.

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. Determination of thermal death time.

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. Microbiological quality standards of food. Government regulatory practices and policies. FDA, EPA, ISI, NABL

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: 60 Hours

Course Outcome:

At the end of this course students will be able to:

CO1: Understand the principles of microorganisms during various food-processing and preservation steps.

CO2: Comprehend the interactions between microorganisms and the food environment, and factors, influencing their growth and survival.

CO3: Understand the significance and activities of microorganisms in food.

CO4: Recognize the characteristics of food-borne, waterborne and spoilage microorganisms, and methods for their isolation, detection and identification.

CO5: Analyze the importance of microbiological quality control programme‟s in food Production. Discuss the microbiology of different types of food commodities.

CO6: Describe the rationale for the use of standard methods and procedures for the microbiological analysis of food.

Text Books:

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

Reference Books:

1.WC Frazier and DC Westhoff (1988), Food Microbiology. Tata McGraw Hill Publishing Company Limited. New Delhi.

2. B Sivasankar (2002) Food Processing and Preservation, Prentice Hall of India Pvt. Ltd.

3. M James. Jay (1996), Modern Food Microbiology, CBS Publishers and Distributors. New Delhi.

4. RC Board (1983) A Modern Introduction to Food Microbiology. Blackwell Scientific Publications, Oxford.

5. CP Ananthakrishnan, RB Singh, PN Padmanabhan (1994) Dairy Microbiology, Sri Lakshmi Publications, Chennai.

6. RK Robinson (2002). Dairy Microbiology, Wiley and Sons. New York.

7. A.J Salle (2001). Fundamental Principles of Bacteriology. Tata McGraw Hill Publishing Company Ltd. 7th Ed.

8. C Samuel. Prescott, Cecil G. Dunn (2005). Industrial Microbiology, Agro Bios India..

9. P Michael. Doyle, R Larry. Beuchat, J Thomas. Montville (2022). Food Microbiology. Fundamentals and Frontiers. ASM Press. 2nd Edition.

Web Sources:

1. Home - Books - NCBI (nih.gov)
2. Microbiological Methods for Water, Soil and Air Analysis | SpringerLink

24PMIM11

L	T	P	O	C
0	0	4	1	2

PRACTICAL – I
PRACTICAL IN GENERAL MICROBIOLOGY AND FOOD MICROBIOLOGY

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 and acquire adequate skill required to evaluate the quality of milk, curd and spoilage organisms.

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. LPCB examination of fungi.Isolation and identification of fungi- *Mucor*, *Rhizopus*, *Aspergillus*, *Penicillium*.
6. Dye Reduction Tests for milk – MBRT test.
7. Evaluation of quality of curd by SPC.
8. Enumeration of bacteria in spoiled foods.
9. Isolation of fungi from spoiled vegetables – Slide Culture Technique
10. Production of Wine

Total – 90 hours

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

CO6: Evaluate the bacteriological quality of milk

CO7: Evaluate the quality of curd and the amount of bacterial growth in spoiled food

24DMIM11 **MICROBIAL PHYSIOLOGY**

L	T	P	O	C
4	0	0	2	4

COURSE OBJECTIVE:

Course Objectives: Students will develop a comprehensive understanding of the physiological processes that govern microbial growth, metabolism, and adaptation to diverse environments. Students will learn how knowledge of microbial physiology can be applied to solve real-world problems in industry, medicine, agriculture, environment and biotechnology.

UNIT- I CELL STRUCTURE AND FUNCTION 12

Cellular architecture: Plasma membrane, cell wall, cytoplasm, and organelles. Structure and types of ion channel. Passive and facilitated diffusion Primary and secondary active transport, concept of uniport, symport and antiport. Metabolic pathways: Glycolysis, Krebs cycle, electron transport chain. Energy production and ATP synthesis.

UNIT-II MICROBIAL GROWTH 12

Growth measurement techniques: Optical density, viable cell count, turbidity. Generation time and specific growth rate, synchronous growth, diauxic growth curve. Factors influencing microbial growth: Temperature, pH, osmolarity, oxygen availability. Reproduction and cell division: Binary fission, budding, sporulation.

UNIT-III METABOLISM AND NUTRIENT UTILIZATION 12

Metabolic diversity among microorganisms: Chemotrophs, phototrophs, autotrophs, heterotrophs. Nutrient acquisition and utilization: Carbon, nitrogen, sulfur, phosphorus and trace elements. Regulation of metabolic pathways: Feedback inhibition, enzyme induction, and repression. Metabolic adaptation to environmental changes.

UNIT – IV MICROBIAL INTERACTIONS AND ECOPHYSIOLOGY 12

Microbial interactions: Mutualism, commensalism, parasitism, competition, microbial antagonistic interactions - predation and antibiosis, for the development of novel antimicrobial agents and biocontrol strategies. Microbial communities and biofilms: Structure, function, and significance. Biofilm formation and quorum sensing. Ecophysiology of extremophiles: Adaptations to extreme environments.

UNIT– V APPLICATIONS OF MICROBIAL PHYSIOLOGY 12

Industrial applications of microbial physiology: biotechnology, food production, biofuels. Medical applications: antibiotic resistance, probiotics, microbial pathogens. Biotechnological approaches for the isolation, cultivation, and utilization of extremophiles in environmental cleanup operations, with a focus on sustainable and eco-friendly remediation strategies.

Total: 60 Hours

Course Outcome:

At the end of this course students will be able to:

CO1: Students will demonstrate a thorough understanding of the physiological processes governing microbial growth, metabolism, and adaptation.

CO2: Students will be able to recognize and describe the diversity of microorganisms and their adaptations to various environmental conditions.

CO3: Students will be able to classify microorganisms based on their metabolic characteristics, including chemotrophs, phototrophs, autotrophs, and heterotrophs, and their contribution to microbial diversity.

CO4: Students will analyse microbial interactions and community dynamics, including mutualism, commensalism, parasitism, and competition in terms of their ecological and medical significance.

CO5: Students will be able to the role of biofilms and quorum sensing in microbial communities, as well as the physiological adaptations of extremophiles to harsh environments.

CO6: Students will be able to apply knowledge of microbial physiology to real-world challenges in biotechnology, medicine, and environment and environmental remediation.

CO7: Students will be able to solve practical problems in various fields such as industry, biotechnology, medicine, and environment.

Text Books:

1. Jr, M.J, Pelczar, N.R. Krieg (1986), Microbiology, 5th edn, McGraw-Hill Book Company, NY.
2. J.L Ingraham, and C.L. Ingraham, (2000), Introduction to Microbiology, 2nd edn, Brooks/Cole, Singapore.
3. J.G. Black (2002), Microbiology: Principles and Explorations, 5th edn, John Wiley and Sons, Inc. NY.

Reference Books:

1. M.T. Madigan and J.M. Martinko (2014), Brock Biology of Microorganisms, 14th edition. Prentice Hall International Inc.
2. A.G. Moat and J.W. Foster (2002), Microbial Physiology, 4th edition, John Wiley & Sons.
3. S.R..Reddy and S.M.Reddy (2005), Microbial Physiology, Scientific Publishers India.
4. G.Gottschalk (1986), Bacterial Metabolism, 2nd edition, Springer Verlag.
5. R.Y. Stanier, J.I. Ingrahm, M.L.Wheelis and P.R. Painter (1987), General Microbiology, 5th edition, McMillan Press.
6. J.M. Willey, L.M. Sherwood and C.J Woolverton (2013), Precott's Microbiology, 9th edition, McGraw Hill Higher Education.

Web Sources:

1. https://spot.colorado.edu/~schmidts/Teaching/EPOB3400/microPhys.html
2. https://dl.icdst.org/pdfs/files3/0bc9d88695de86f1fbad48fe3fccffc9.pdf
3. https://nsdl.niscpr.res.in/bitstream/123456789/803/1/CarbonMetabolism.pdf

24DMIM12 BIOSAFTETY AND INTELLECTUAL PROPERTY RIGHTS (IPR)

L	T	P	O	C
4	0	0	2	4

COURSE OBJECTIVE:

The course aims to provide a comprehensive understanding of biosafety and risk assessment for handling biological agents safely. Familiarize with national and international biosafety regulations and the role of organizations like WHO and CDC. Explore the fundamentals of intellectual property rights (IPR) and their significance in biotechnology.

UNIT- I BIOSAFETY: INTRODUCTION AND GUIDELINES 12

Introduction, biosafety issues; Biological Safety Cabinets & their types; Primary Containment for Biohazards; Biosafety Levels of Specific Microorganisms. Biosafety Guidelines: Biosafety guidelines and regulations (National and International); GMOs/LMOs- Concerns and Challenges; Role of Institutional Biosafety Committees (IBSC), RCGM, GEAC etc. for GMO applications in food and agriculture;

UNIT-II RISK ANALYSIS AND GUIDELINES 12

Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of International Agreements - Cartagena Protocol. Use of Animals in Research and Testing, and Alternatives for Animals in Research, Animal Cloning, Human Cloning and their Ethical Aspects. Testing ofDrugs on Human Volunteers Public and Non-Governmental Organizations (NGOs)Participation in Biosafety and Protection of Biodiversity.

UNIT-III INTRODUCTION TO INTELLECTUAL PROPERTY 12

Introduction to Intellectual Property and History. Patents, Trademarks, Copyright , Trade secrets, Industrial Design and Rights, Traditional Knowledge, Geographical Indications - importance of IPR – patentable and non patentable – patenting life – legal protection of biotechnological inventions – World Intellectual Property Rights Organization (WIPO), Ethics, Pros and Cons of IP protection.

UNIT – IV GRANT OF PATENT, PATENTING AUTHORITIES AND TREATIES 12

Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; An introduction to Patent Filing Procedures; Patent licensing and agreement; Patent infringement- meaning, scope, litigation, case studies, Rights and Duties of patent owner. Agreements and Treaties: GATT, TRIPS Agreements; WIPO Treaties; Budapest Treaty on international recognition of the deposit of microorganisms; UPOV & Brene conventions;

UNIT– V BIOSAFETY IN BIOTECHNOLOGY AND ETHICAL

CONSIDERATIONS **12**

Definition and importance of biosafety in biotechnological research. Types of Biological Risks. Pathogenic microorganisms, genetically modified organisms (GMOs), and biohazards. Risk assessment strategies in biotechnology.

Total: 60 Hours

Course Outcome:

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

CO1: Demonstrate a thorough understanding of the principles and practices of biosafety in biotechnology against the biological risks.

CO2: Analyze the ethical implications of using genetically modified organisms (GMOs) and other biotechnological innovations, considering their impact on human health and the environment.

CO3: Critically assess case studies related to biosafety incidents and improvements to current biosafety practices and regulations.

CO4: Develop effective communication strategies to engage with the public and address concerns regarding biotechnology and its implications for health and safety.

CO5: Expalin the regulatory and ethical frameworks governing biotechnology, including national and international guidelines.

CO6: Collaborate effectively with peers and professionals from various disciplines to address biosafety challenges and ethical considerations in biotechnological research.

CO7: Evaluate emerging trends in biotechnology and their potential impact on biosafety regulations, ethical standards, and public policy.

Text Books:

4. . Shomini Parashar, Deepa Goel (2013), IPR, Biosafety and Bioethics Pearson India

Reference Books:

1. R. J. M. A. Van den Borne, J. A. H. Van der Linde, and G. M. J. L. Thewessen (2018), Biosafety in Microbiological and Biomedical Laboratories, 5th edn, U.S. Department of Health and Human Services, Washington, D.C.
2. B. J. Campbell, L. L. K. Trivett, and C. E. Redman (2017), Biotechnology and Biosafety: A Practical Guide, 1st edn, Wiley-Blackwell, Hoboken, NJ.

24DMIM13 BIOCHEMICAL TECHNIQUES AND INSTRUMENTATION

L	T	P	O	C
4	0	0	2	4

COURSE OBJECTIVE:

The candidate will understand the techniques and instrumentation used in biochemical research.

UNIT- I MICROSCOPY 12

Principle, working, types and application of microscopy; Light microscopy, Fluorescence microscopy, Phase contrast microscopy, Confocal microscopy, Electron Microscopy. Staining techniques- simple staining, differential staining, special staining. Sample preparation for electron microscopy.

UNIT-II pH AND CENTRIFUGATION 11

pH meter: Principles and instrumentation, Centrifugation: Principles, types of centrifuges, types of rotors, differential, density gradient centrifugation and ultra centrifugation.

UNIT-III SPECTROPHOTOMETRY AND CHROMATOGRAPHY 13

Principle, working, types and application of spectrophotometer- visible spectrophotometry, UV spectrophotometry. Infrared spectrometers - Luminometry and densitometry. Mass Spectroscopy. Principle, technique and applications of paper, TLC, HPTLC, column, affinity, ion exchange, gel filtration chromatography. GC, GC-MS, HPLC

UNIT – IV NUCLEIC ACID BASED TECHNIQUES 13

Nucleic acid extraction, quantification, purity checking. Nucleic acid amplification techniques- PCR, its modifications and applications. Nucleic acid sequencing- Maxam and Gilbert, Sangers sequencing, Next generation sequencing

UNIT– V ELECTROPHORESIS AND BLOTTING TECHNIQUES 11

Principle, technique and applications of paper, gels - Agarose, Native and SDS PAGE, Isoelectric focusing. Principle, technique and applications of western, southern and northern blotting. Chemiluminescence and Phosphorimaging.

Total: 60 Hours

Course Outcome:

At the end of this course students will be able to:

CO1: Understand the principles and applications of major biochemical techniques

CO2: Explain the working and usage of microscopes

CO3: Illustrate the Nucleic acid based techniques

CO4: Assess the implications of various spectrophotometric methods and chromatographic methods

CO5: Distinguish the different centrifugation techniques

CO6: Elaborate electrophoresis and blotting techniques

CO7: Discuss the advantages and limitations of various biochemical techniques

Text Books:

1. Sawhney and Singh (2015), Introductory Practical Biochemistry, 11th edition, Narosa Publishing House, New Delhi.
2. Wilson and Walker (2018), Principles and Techniques of Biochemistry and Molecular Biology, 8th edition, Cambridge University Press, London.

Reference Books:

1. R.F. Boyer (2012), Modern Experimental Biochemistry, 3rd edition, Pearson Education Inc, New York.
2. T.G. Cooper (2011), The Tools of Biochemistry, 1st edition, John Wiley and Sons, New Jersey.
3. J. Pelczar, Chan and Krieg (2012), Microbiology, 5th Edition, Tata McGraw Hill, New York.
4. S. Srivastava (2010), Molecular Techniques in Biochemistry and Biotechnology, 1st edition, New Central Book Publishers, Kolkata.
5. P.K. Bajpai (2006), Biological Instrumentation and methodology, S. Chand & Co. Ltd.
6. S.E. Ruzin (1999), Plant micro technique and microscopy, Oxford University Press, New York, U.S.A.

24DMIM14 **ANTIMICROBIAL AGENTS AND RESISTANCE**

L	T	P	O	C
4	0	0	2	4

COURSE OBJECTIVE:

The course aims to provide a comprehensive understanding of antimicrobial agents and their mechanisms of action against pathogens. Familiarize students with the biological mechanisms of antimicrobial resistance and the factors contributing to its emergence. Evaluate the clinical implications of antimicrobial resistance on public health and treatment outcomes. Formulate strategies for antimicrobial stewardship and infection control in healthcare settings. Explore current research trends in the development of new antimicrobial agents and global efforts to combat antimicrobial resistance.

UNIT- I INTRODUCTION TO ANTIMICROBIAL AGENTS 12

Overview of antimicrobial agents: antibiotics, antivirals, antifungals, and antiparasitics. Mechanisms of action of different classes of antimicrobials. Pharmacokinetics and pharmacodynamics of antimicrobial agents. Historical perspective and discovery of antimicrobials.

UNIT-II MECHANISMS OF ANTIMICROBIAL RESISTANCE 12

Genetic and biochemical mechanisms of resistance in bacteria, viruses, fungi, and parasites. Horizontal gene transfer and its role in resistance dissemination. Environmental and clinical factors contributing to the development of resistance. Case studies of specific resistant pathogens (e.g., MRSA, VRE, C. difficile).

UNIT-III CLINICAL IMPLICATIONS OF ANTIMICROBIAL RESISTANCE 12

Impact of antimicrobial resistance on public health: morbidity, mortality, and economic burden. Challenges in diagnosing and treating resistant infections. Antimicrobial resistance surveillance and reporting systems. Role of healthcare professionals in managing and preventing resistance.

UNIT – IV ANTIMICROBIAL STEWARDSHIP AND INFECTION CONTROL 12

Principles of antimicrobial stewardship and its importance in healthcare settings. Infection control measures to prevent the spread of resistant pathogens. Guidelines and protocols for the appropriate use of antimicrobials. Strategies for patient education and public awareness regarding antimicrobial resistance.

UNIT– V RESEARCH AND GLOBAL PERSPECTIVES ON ANTIMICROBIAL RESISTANCE 12

Current research trends in the development of new antimicrobial agents and alternative therapies (e.g., phage therapy, vaccines). Role of international organizations (e.g., WHO, CDC) in combating antimicrobial resistance. Global burden of antimicrobial resistance and successful public health interventions. Ethical considerations in antimicrobial research and development

Total: 60 Hours

Course Outcome:

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

CO1: Demonstrate a comprehensive understanding of the various classes of antimicrobial agents, their mechanisms of action, and pharmacological properties.

CO2: Analyze and explain the biological mechanisms underlying antimicrobial resistance in different pathogens, including bacteria, viruses, fungi, and parasites.

CO3: Evaluate the clinical implications of antimicrobial resistance on patient care, treatment outcomes, and public health.

CO4: Formulate and propose effective antimicrobial stewardship and infection control strategies to minimize the development and spread of resistance in healthcare settings.

CO5: Assess and interpret laboratory techniques used for identifying pathogens and determining their susceptibility to antimicrobial agents.

CO6: Investigate current trends and advancements in antimicrobial research, including the development of new agents and alternative therapeutic approaches.

CO7: Analyze the global impact of antimicrobial resistance and the role of international organizations in implementing strategies to combat this public health threat.

Text Books:

1. Friedman, N. D., Kaye, K. S., Stus, V., et al. (2020), Antimicrobial Resistance in the 21st Century: A New Perspective, Oxford University Press, Oxford.

Reference Books:

1. Lorian, V. (2016), Antibiotics in Laboratory Medicine, 5th edn, Wolters Kluwer Health, Philadelphia, PA.

2. Levy, S. B., and Marshall, B. (2020), Antibiotic Resistance: A Problem of Global Dimensions, Springer, New York, NY.

3. Gootz, T. D., and Macielag, M. J. (2019), Antimicrobial Drug Resistance: Mechanisms and

Clinical Impact, 2nd edn, Wiley-Blackwell, Hoboken, NJ.

4. Agarwal, R., and Kaur, R. (2019), Principles and Practice of Antimicrobial Therapy, Elsevier, Amsterdam.

5. Davies, J., and Davies, D. (2010), Origins and Evolution of Antibiotic Resistance, Microbiology and Molecular Biology Reviews, 74(3), 417-433.

6. Wiley, A. (2018), Antibiotic Resistance: Understanding and Combatting the Global Challenge, Springer, Cham.

Web Sources:

1. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6604941/
2. https://amrls.umn.edu/microbiology

24SSKP11 **SOFT SKILLS 1**

L	T	P	O	C
2	0	0	1	2

COURSE OBJECTIVE:

- To enable participants Business Communication Skills
- To enhance participants E-mail writing skills
- To impart Leadership and Team Bonding skills

UNIT- I READING COMPREHENSION AND VOCABULARY 06

Filling the blanks – Cloze Exercise – Vocabulary building – Reading and answering Questions.

UNIT- II LISTENING AND ANSWERING QUESTIONS 06

Listening and writing – Listening and sequencing sentences – Filling in the blanks Listening and answering questions.

UNIT- III GROUP DISCUSSIONS 06

Why GD part of a selection process – Structure of a GD – strategies in GD- Team Work – Body Language

UNIT- IV CONVERSATION. 06

Face to face Conversation and Telephone conversation

UNIT- V SELF- INTRODUCTION AND ROLE PLAY 06

Total: 30 Hours

COURSE OUTCOMES:

At the end of this course the students will be able to,

At the end of this course the students will be able to,

CO 1 Prioritize power of understanding and aids assimilation of vocables. Vocabulary to charge communication with educated words

CO 2 Develop comprehensive knowledge through listening leading to answering questions

CO 3 Build observation power and infuse self-confidence through group discussions

CO 4 Identify methodology for befitting constructional ability

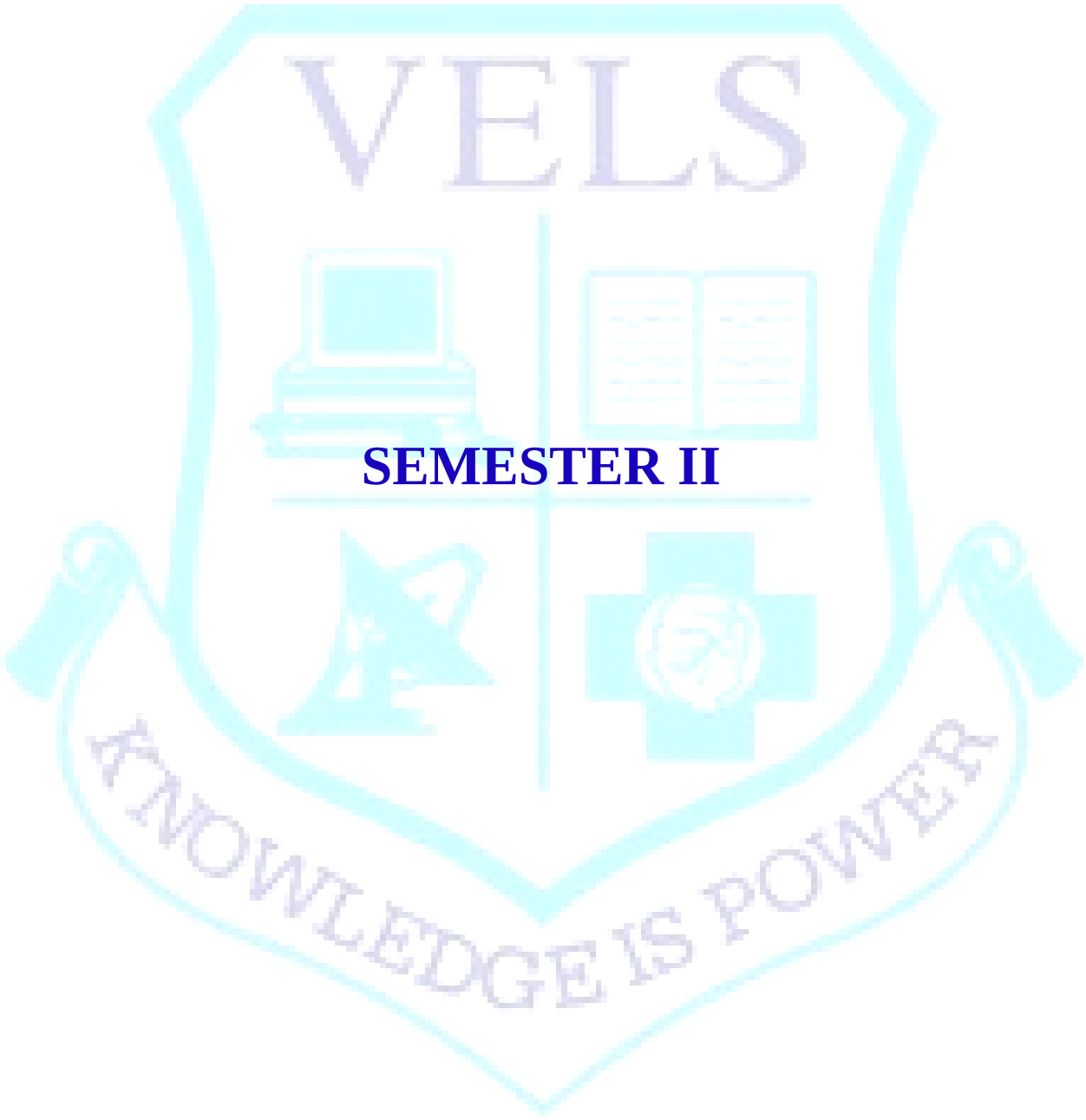
CO 5 Experiments with inward looking and visualization of the ‘otherness’ of situations

Books Recommended

- Barun K. Mitra. Personality Development and Soft Skills. Oxford University Press. New Delhi.2011.
- S.P. Sharma. Personality Development. Pustaq Mahal. New Delhi. 2010.Meenakshi Raman and Sangeetha Sharma. Technical Communication. Oxford University Press. New Delhi. 2009.
- Tiko, Champa & Jaya Sasikumar. Writing with a Purpose.OUP. New Delhi. 1979

Web Sources:

- https://www.skillsyouneed.com/ips/communication-skills.html
- https://blog.smarp.com/top-5-communication-skills-and-how-to-improve-them
- https://blog.hubspot.com/service/phone-etiquette



SEMESTER II

24CMIM21 CELL CULTURE AND FERMENTATION TECHNOLOGY

L	T	P	O	C
4	0	0	2	4

COURSE OBJECTIVE:

The candidate will gain knowledge about the principles and processes of fermentation, including microbial growth kinetics and types of fermentation. Learn media formulation, optimization, and fermentor design for effective industrial microbiology processes. Acquire techniques for animal and mammalian cell culture, with applications in biopharmaceuticals.

UNIT- I INTRODUCTION TO FERMENTATION PROCESS 12

General consideration of fermentation process. Principles of fermentation: aerobic vs. anaerobic. Screening and selection of industrially important cultures and Inoculum development. Types of fermentation processes: batch, fed-batch, continuous. Microbial growth kinetics and substrate utilization.

UNIT-II MEDIA FORMULATION 12

Importance of media formulation in industrial microbiology processes. Differences between laboratory-scale and industrial-scale media. Basic Nutrients in Industrial Media. Sterilization of Industrial Media. Optimization of Industrial Media. Response Surface Methodology (RSM) for identifying optimal conditions. Scale-Up Considerations. Economic considerations in selecting media components.

UNIT-III DESIGN OF FERMENTOR 12

Fermenter design: Aeration and agitation. Control and Monitoring Systems: Temperature control (heating and cooling systems) pH control (acid/base addition) Dissolved oxygen control (aeration rate, oxygen-enriched air) Foam control (antifoam addition, mechanical foam breakers) Sensors and probes (e.g., pH, dissolved oxygen, temperature). Types of fermentor. Control of fermentation process.

UNIT – IV ANIMAL CELL CULTURE 12

Types of cell cultures: primary culture, secondary culture, continuous cell lines. Sterile techniques and laboratory safety. Cell Culture Media: Components of cell culture media: amino acids, vitamins, salts, glucose, growth factors, and serum. Serum-free media and its advantages. Cell Growth and Viability: Methods to assess cell viability and proliferation (trypan blue exclusion, MTT assay, etc.).

UNIT– V MAMMALIAN CELL CULTURE AND APPLICATIONS 12

Industrial applications of microbial physiology: biotechnology, food production, biofuels.

Medical applications: antibiotic resistance, probiotics, microbial pathogens. Biotechnological approaches for the isolation, cultivation, and utilization of extremophiles in environmental cleanup operations, with a focus on sustainable and eco-friendly remediation strategies.

Total: 60 Hours

Course Outcome:

At the end of this course students will be able to:

CO1: Understand the principles of fermentation, distinguish between aerobic and anaerobic processes, and understand microbial growth kinetics and substrate utilization.

CO2: Formulate and optimize industrial media, apply sterilization techniques, and consider economic factors and scale-up in media preparation.

CO3: Gain proficiency in designing and controlling fermentors, including aeration, agitation, temperature, pH, dissolved oxygen, and foam control.

CO4: Discuss strategies for controlling fermentation processes using advanced sensors and probes to monitor and adjust key parameters in real-time.

CO5: Analyze the impact of fermentor design and operational parameters on microbial productivity and product quality.

CO6: Acquire skills in animal cell culture, including sterile techniques, media preparation, cell viability assessment, sub-culturing, and cryopreservation.

CO7: Discuss challenges and strategies associated with scaling up animal cell culture techniques for large-scale production and biopharmaceutical applications.

Text Books:

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

Reference Books:

1. Glyn Stacey (2007), Medicines from Animal Cell Culture, John Wiley and Sons Ltd.
2. Ralf Portner (2007), Animal Cell Biotechnology: Methods and Protocols (Methods in Biotechnology), Humana Press Inc., U.S.
3. Sadettin Ozturk and Wei-Shou Hu (2004), Cell Culture – Technology for Pharmaceutical and Cell– Based Therapies (Biotechnology and Bioprocessing), Taylor and Francis.

4. M. Butler (2003), Animal Cell Culture and Technology: The Basics; Garland Science.
5. J.M. Davis (2002), Basic Cell Culture: A Practical Approach, Oxford University Press.
6. P.F. Stanbury Whitaker S.J. Hall (1995), Principles of Fermentation Technology; Pergamon Press. 1995.

Web Sources:

1.https://www.pace.edu.in/img/course/COURSE%20MATERIAL_4TH_YEAR_18BT71_MODULE_1.pdf

2.https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000014ER/P000284/M025601/ET1513594624Paper15EMB_Module21__etext.pdf

24CMIM22 **MOLECULAR IMMUNOLOGY AND IMMUNOGENETICS**

L	T	P	O	C
4	0	0	2	4

COURSE OBJECTIVE:

The course gives the students an understanding of the genes that control the properties of immunoglobulins. The students will also gain insights on the genetic basis of antibody and TCR diversities. The students will develop an appreciation of how the MHC/HLA genes are involved in haplotyping. The course gives a detailed insight on the genetic basis of cancer development.

UNIT- I IMMUNOGLOBULIN GENETICS 12

Immunoglobulin genes and gene rearrangement. Genetic structure and isotypes of heavy and light chains. Isotype switching. Generation of antibody diversity. Allotypes, and Idiotypes. Genetics of complement components.

UNIT-II GENETICS OF T CELL RECEPTOR 12

Genetics of T cell receptor. TCR gene rearrangement. Mechanisms of generation of diversity of TCR. T cell surface alloantigens, other markers of Human T and B lymphocytes. T lymphocyte sub populations.

UNIT-III MHC GENES AND PRODUCTS 12

The major histocompatibility complex – MHC genes. Class I and Class II MHC molecules-Structure and functions. The HLA system-Antigens and HLA Typing. Genes associated with complement proteins.

UNIT – IV BLOOD GROUPS AND ABO, Rh GENETICS 12

An overview of blood groups and types-ABO and Rh system. Genetic basis of ABO blood group, Bombay blood groups and Secretors/Non-secretors. Genetic basis of Rh system. Wiener's and Fischer Race theories. Minor blood groups and antigens. ABO and Rh incompatibilities.

UNIT– V IMMUNOGENETICS OF CANCER 12

Genetics of neoplastic cell antigens- CEA, AFP and others. Protooncogenes, tumor suppressor genes, *c-onc*, *v-onc* genes. Immune surveillance in cancer, immune responses against tumor antigens-humoral and cell-mediated immunity. Vaccines and immunotherapeutics for cancer- strategies in cancer therapy.

Total: 60 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 tumor antigens and the expression of oncogenes.

CO4: Highlight the role of MHC genes and products.

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

CO6: Appraise the immune mechanisms generated against tumor antigens.

CO7: Explain the various immunotherapeutic strategies against cancer.

Text Books:

1. T. Frank Christiansen and D. Brian Tait (2003), Immunology – A Short Course, 5th Edition, Wiley- Liss, New York.

Reference Books:

1. Ivan M. Roitt, J. Brostoff and D. K. Male (1993), Immunology, Gower Medical Publishing, London.
2. W.R. Clark (1991), The experimental foundations of modern immunology, John Wiley and Sons Inc, New York.
3. Jenni Punt, Sharon A. Stranford, Patricia P. Jones, Judith A. Owen and Janis Kuby (2019), Kuby Immunology, 8th Edition, W. H. Freeman and Company, New York.
4. Janeway Travers (1997), Immunobiology- the immune system in health and disease, 3rd Edition, Current Biology Ltd. London, New York.
5. Peter J. Delves and Ivan M. Roitt (1998) Encyclopedia of Immunology, 2nd Edition, Academic Press.
6. H. Chapel and M. Halbey (1986), Essentials of Clinical Immunology. ELBS edition.
7. Leslie Hudson and Frank C. Hay (1989), Practical Immunology, 3rd Edition, Blackwell Scientific Publication.
8. Pravash Sen. Gupta (2003), Clinical Immunology, Oxford University Press.
9. Noel R. Rose, Herman Friedman and John L. Fahey (1986), Manual of Clinical Laboratory Immunology, 3rd Edition, American Society for Microbiology.

Web Sources:

6. https://www.ncbi.nlm.nih.gov/books/NBK2267/pdf/Bookshelf_NBK2267.pdf
7. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3595629/pdf/ijph-42-1.pdf
8. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10445970/
9. https://www.nature.com/articles/s41392-024-01856-7

24CMIM23 **MEDICAL BACTERIOLOGY**

L	T	P	O	C
4	0	0	2	4

COURSE OBJECTIVE:

The candidates will be able to understand the pathogenesis of infections caused by bacterial pathogens in humans and the immune response by the host. The students will also be able to identify the causative organisms responsible for infections. The students gain knowledge in both theoretical and practical implementation of the testing methods employed for the detection of bacteria. The students will go through a comprehensive analysis of the treatment strategies, epidemiology and management of infections caused by bacterial pathogens.

UNIT- I OVERVIEW OF HOST PARASITE INTERACTIONS 12

Normal flora of human body. An overview of bacterial virulence factors-host colonization, invasion, tissue damage and immune evasion. Immune responses of the host against bacterial infections – Innate and adaptive immune responses. Host parasite interactions.

UNIT-II PATHOGENESIS, CLINICAL MANIFESTATIONS AND IDENTIFICATION OF PATHOGENS 12

Pathogens, pathogenesis, clinical manifestations, laboratory diagnosis, treatment and prevention of diseases caused by species of *Staphylococcus*, *Streptococcus, C. diphtheriae, Y. pestis, B. pertussis, M. tuberculosis*, *N. meningitidis, S. typhi, V. cholerae*.

UNIT-III MODE OF TRANSMISSION 12

Infections spread through genitourinary tract – gonorrhea, syphilis; Direct contact-Leprosy, Leptospirosis; Wound and Burns- Tetanus, gas gangrene. Infections of eye-Conjunctivitis, Trachoma. Infections of the oral cavity.

UNIT-IV EMERGING INFECTIONS, PUBLIC HEALTH AND TREATMENT 12

An overview of emerging and re-emerging bacterial infections. Epidemiology and control of community and nosocomial infections. Antibiotics-classification-mode of action, antimicrobial resistance – mechanisms, tackling AMR-surveillance, antibiotic policy-stewardship.

UNIT– V DIAGNOSTIC BACTERIOLOGY 12

Rules for collection and dispatch of clinical specimens for microbiological diagnosis; Recommendations for the collection, transport and isolation of bacteria from clinical specimens. General principles, media and isolation techniques involved for anaerobic bacteria.

Total: 60 Hours

Course Outcome:

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

CO1: Relate the mechanisms and interactions between the host and the pathogen.

CO2: Explain the pathogenesis and infection process of bacterial pathogens that invade the host.

CO3: Appraise the virulence characters and mechanisms of the pathogens.

CO4: Explain the emerging and reemerging infections caused by bacteria.

CO5: Perceive the concept of AMR and antibiotic stewardship

CO6: Distinguish nosocomial and community acquired infections and infection control strategies.

CO7: Evaluate the sample collection and processing for identification of bacteria.

Text Books:

1. R. Ananthanarayanan and C. K. Jeyaram Panicker (2006), Textbook of Microbiology, 8th Ed., Orient Longman.

Reference Books:

1. E. Jawetz, J.L. Melnick, E.A. Adelberg (1998), Review of Medical Microbiology, Ed. 19, Lange Medical Publications, ELBS, London.
2. David Greenwood, B. Richard, Slack John F. Peutherer (2002), Medical Microbiology, Ed.16, Churchill Livingstone, London.
3. E.J. Baron, S.M. Fine Gold (1995), Diagnostic Microbiology, Blackwell Scientific Systems.
4. J.G. Colle, A. Simmons, A.G. Fraser, B.P. Marmion (2006), Mackie & McCartney Practical Medical Microbiology, 14th Edition, Churchill Livingstone, Elsevier.
5. Cowan and Steel (1995), Cowan & Steel's Manual for Identification of Medical Bacteria, 4th Edition, Cambridge University Press, London.
6. Wolfgang, Joklik and David J. Smith (1990), Zinsser's Microbiology, 11th Edition, Appleton Century Crafts, N.Y.
7. Topley and Wilson (1990), Topley & Wilson's Principles of Bacteriology, Virology & Immunity, Vol III, Bacterial Diseases, 8th Edition, Edward Arolla, London.

Web Sources:

1. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8308756/
2. https://www.sciencedirect.com/science/article/pii/S1198743X18301812

24PMIM21 **PRACTICAL - II**

PRACTICAL IN IMMUNOLOGY AND BACTERIOLOGY

L	T	P	O	C
0	0	4	1	2

COURSE OBJECTIVE:

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

1. Identification of various immune cells by morphology – Leishman staining.
2. Heamagglutination Reactions- Blood Grouping methods– forward grouping and reverse grouping, Rh Typing, TPHA.
3. Agglutination Reactions- Latex Agglutination reactions- RF, ASO, CRP.
4. Collection and transport of specimens- Faeces, pus, sputum, throat/ ear/ nasal/ wound swab, CSF and other body fluids.
5. Identification of medically important pathogenic bacteria- *Staphylococci*, *Streptococci, E. coli, Proteus, Klebsiella, Shigella, Pseudomonas, Salmonella, Vibrio* species.
6. 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.
7. Cultivation of viruses by egg inoculation methods.
8. Blood smear examination for malarial parasites.

Total: 90 Hours

Course Outcome:

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

CO1: Identify the white blood cells in blood smear.

CO2: Develop skills in immunology laboratory experiments.

CO3: Determine the concentration of antibodies in serum by latex agglutination reactions.

CO4: Analyze the collection and processing methods of clinical specimen.

CO5: Identify the bacterial pathogens based on their characteristics.

CO6: Examine the fecal specimens for ova and cyst of parasites.

CO7: Develop skills in egg inoculation techniques for cultivation of viruses.

Text Books:

1. Leslie Hudson and Frank C Hay (1976), Practical Immunology, Blackwell Scientific Publicaitons, Oxford.

2. J.G. Collee, A.G Fraser, B.P Marmion, A Simmons (1996), Mackie & McCartney Practical Medical Microbiology, 14th edition, Churchill Livingstone, Elsevier.

24PMIM22 **PRACTICAL-III**

L	T	P	O	C
0	0	4	1	2

PRACTICAL IN MOLECULAR BIOLOGY

COURSE OBJECTIVE:

The candidate will gain hands-on knowledge and acquire adequate skill required to separate and observe chromosomal DNA, RNA, amino acids, lipids as well as estimate nucleic acids.

1. Isolation of Antibiotic Resistant bacteria from soil samples.
2. Isolation of plasmid DNA and its demonstration by agarose gel electrophoresis.
3. Study survival curve of bacteria after exposure to ultraviolet (UV) light
4. Study the effect of chemical and physical (UV) mutagens on bacterial cells
5. Isolation of plasmid DNA and its demonstration by agarose gel electrophoresis.
6. Isolation of bacterial chromosomal DNA and demonstration.
7. PCR-standard amplification.
7. Quantitation of DNA and RNA by chemical methods-Dinitrophenol, orcinol, physical method – UV adsorption (Estimation of DNA by chemical method).
8. Preparation of competent cells. Gene transfer by conjugation method.
8. Estimation of proteins – Lowry method; Bradford method
9. Electrophoretic methods – PAGE native PAGE.
10. Separation of amino acids by paper chromatography.
11. TLC – Plant pigments, amino acids, lipids and vitamins. Protein separation by aqueous two phase partitioning.

Total: 90 Hours

Course Outcome:

At the end of this course students will be able to:

CO1: Explain the principles of chromatography and electrophoresis techniques (Understanding).

CO2: Perform gel electrophoresis and HPLC experiments using proper techniques and safety protocols (Applying).

CO3: Analyze experimental data from molecular separation experiments to interpret results (Analyzing).

CO4: Evaluate the reliability of chromatographic separations for different types of molecules (Evaluating).

CO5: Design a protocol for a novel molecular separation experiment to separate specific biomolecules (Creating).

CO6: Design a protocol for a novel molecular separation experiment to address a specific research question or problem.

CO7: List different types of molecular separation methods and their basic components

Practical - Molecular Biology

Reference Books:

1. S. Kanniyan, (2003), Biotechnology of Biofertilizers, Texas.
2. K. Mahendra Rai (2005), Hand book of Microbial biofertilizers, The Haworth Press, Inc New Yark.
3. S.M. Reddy (2002), Bioinoculants for sustainable agriculture and forestry, Scientific Publication.

24DMIM21 MICROBIAL GENETICS AND MOLECULAR BIOLOGY

L	T	P	O	C
4	0	0	2	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 12

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 12

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 12

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 DARK DNA TECHNOLOGY 12

Primer Designing, Next-generation sequencing technologies, Whole Genome Sequencing, Genome assembly and annotation, Comparative genomics and evolutionary insights, RNA Expression. 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 Foot printing.

Total: 60 Hours

Course Outcome:

At the end of this course students will be able to:

CO1: Discuss 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 the Central Dogma.

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

CO5: Select suitable methods for biomolecular analysis.

Text Books:

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

Reference Books:

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

24DMIM22 **CLONING STRATEGIES AND NANOTECHNOLOGY**

L	T	P	O	C
4	0	0	2	4

COURSE OBJECTIVE:

The candidate will gain knowledge of genetic engineering, including gene transfer mechanisms and related phenomena, as well as various cloning strategies essential for modern biotechnology. The course will also explore the principles of nanomicrobiology and nanotechnology, focusing on their applications in health, agriculture, and environmental sciences. Students will learn about the tools and techniques used in genetic manipulation and the design of nanomaterials, preparing them for innovative research and development in these rapidly evolving fields.

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 CLONING STRATEGIES AND APPLICATIONS 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 Hours

Course Outcome:

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

CO1: Students will demonstrate an understanding of the basic principles of genetic engineering, including the isolation, purification, and manipulation of DNA from various sources.

CO2: Students will effectively apply polymerase chain reaction (PCR) and pulse field electrophoresis techniques for the analysis of large DNA fragments.

CO3: Students will evaluate and select appropriate cloning vectors for different host systems, including prokaryotic and eukaryotic organisms, based on the characteristics of ideal vectors.

CO4: Students will describe and utilize various methods of gene transfer, including electroporation, microinjection, and particle bombardment, for effective gene delivery.

CO5: Students will employ and compare different screening techniques for recombinant identification, such as blue-white screening and immunodetection, to assess successful cloning efforts.

CO6: Students will critically analyze the socio-economic ethics of cloning and apply NIH guidelines, understanding their implications for scientific research and public policy.

CO7: Students will explore the principles and applications of nanomicrobiology and nanobiotechnology, focusing on the use of nanoparticles in diagnostics, drug delivery, and nanofabrication, integrating knowledge from previous units to propose innovative solutions in biotechnology.

Text Books:

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

Reference Books:

1. T.A. Brown, (2001).Gene cloning and DNA analysis- An introduction, Blackwell Science Publishers. Ed.4;
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

24SSKP21 **SOFT SKILLS II**

L	T	P	O	C
2	0	0	1	2

COURSE OBJECTIVE:

- To enable students to develop their communication skills effectively
- To enhance students Reading, Writing, Listening and Speaking skills
- To develop their self-confidence through communication

UNIT- I PRESENTATION SKILLS 06

Elements of an effective presentation – structure of presentation – voice modulation –Audience analysis – Body language

UNIT- II SOFT SKILLS 06

Time Management – Articulateness – Assertiveness – Stress management

UNIT- III RESUME / REPORT PREPARATION / LETTER WRITING 06

Structuring the resume / Report – Business letters – E-Mail Communication

UNIT- IV INTERVIEW SKILLS 06

Kinds of Interviews – Required by Skills – Corporate Culture – Mock Interviews

UNIT- V 30 FREQUENTLY ASKED QUESTIONS 06

Total: 30 Hours

COURSE OUTCOMES:

At the end of this course the students will be able to,

At the end of this course, the students will be able to,

CO1 Illustrate the essentials of presentation skills, thoughts, structure, voice modulation, audience analysis, and body language

CO2 Utilize the psychological skills pertaining to time management, articulation, assertion, and stress management

CO3 Construct methodology for the preparation of resumes, reports, business letters, and email communication

CO4 Appraise learners with varied skills needed for exposure to interviews

CO5 Categorize the nature of questions asked usually in interviews

Books Recommended

- Barun K.Mitra. Personality Development and soft skills. Oxford University Press. New Delhi. 2011.

- S P Sharma. Personality Development. Pustaq Mahal. New Delhi. 2010.
- Meenakshi Raman and Sangeetha Sharma. Technical Communication. Oxford University Press. New Delhi. 2009.

Web Sources:

- https://www.skillsyouneed.com/ips/communication-skills.html
- https://www.businessnewsdaily.com/5836-top-interviewing-skills.html
- https://gdpi.hitbullseye.com/Group-Discussion.php

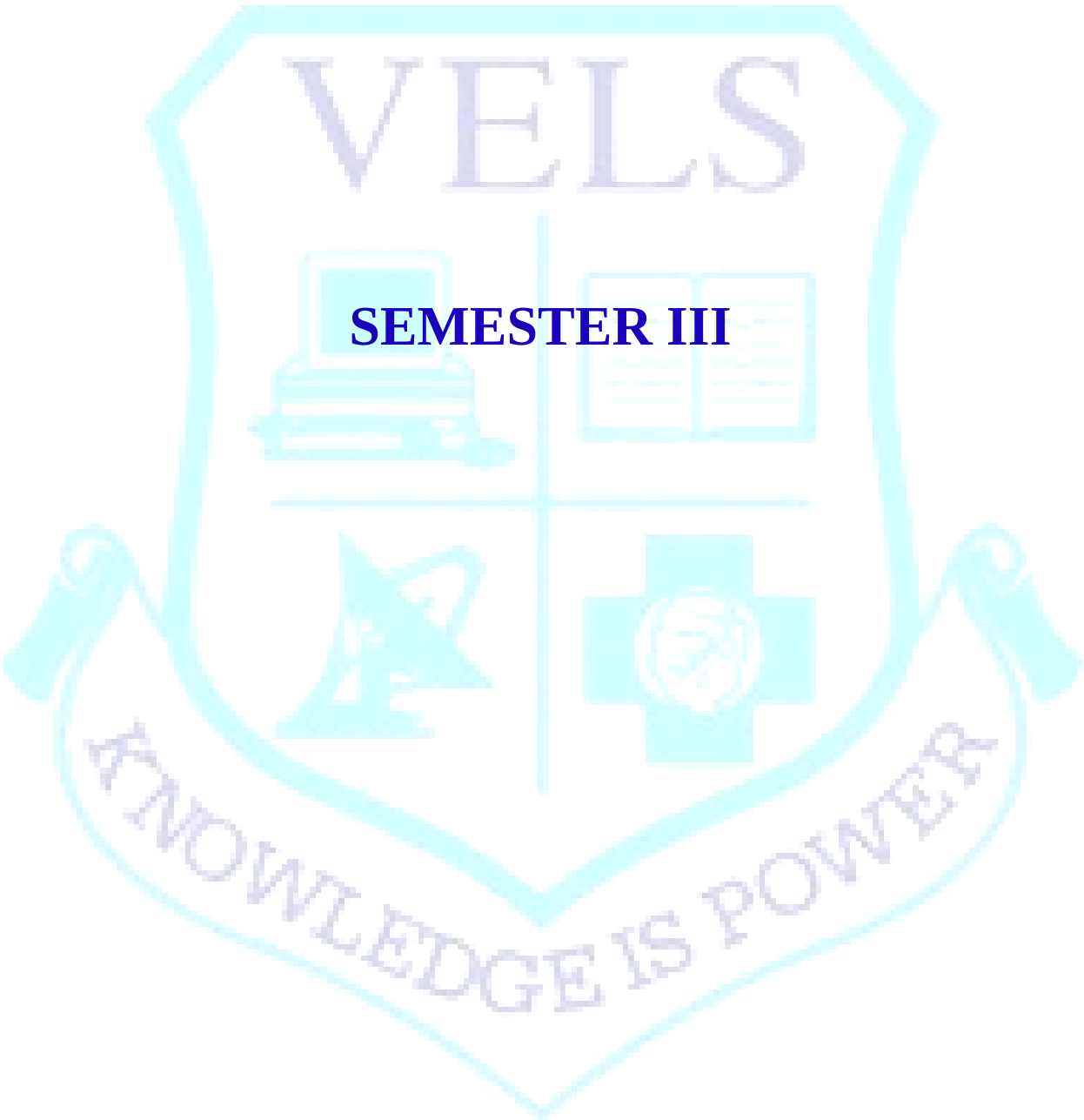
24INPG21 **INTERNSHIP**

L	T	P	O	C
0	0	2	1	2

COURSE OBJECTIVE:

Students are required to participate in a training program at a recognized microbiology or biotechnology industry, research institute, or laboratory to gain practical experience through hands-on training. Upon completion of the training, students must submit a comprehensive report detailing the techniques learned and the work carried out during the training.

- To enhance student skillsets, attending at least one internship or mini project during semester breaks is mandatory.
- Students should engage in internships or mini projects at microbiological institutions to gain hands-on experience in laboratory techniques.
- After completing the internship or mini project, students must submit a detailed, printed report documenting the learning and work carried out during the program.
- Evaluation will be based on the work completed, the quality and content of the report, and performance in a viva-voce and presentation session.



SEMESTER III

24CMIM31 CLINICAL IMMUNOLOGY AND VACCINOLOGY

L	T	P	O	C
4	0	0	2	4

COURSE OBJECTIVE:

The candidate will gain updated and comprehensive knowledge about immunological mechanisms against infections, humoral and cell-mediated immunity, autoimmunity mechanisms, immunodiagnostic tests, assays, and vaccines. This course ensures preparedness for clinical applications, competitive exams, and alignment with regional and global health priorities.

UNIT I OVERVIEW OF MICROBIAL PATHOGENS 12

Microbial pathogens – Bacterial, Viral and Fungal Pathogens and Parasitic diseases. Bacterial-extracellular bacteria, Focus on emerging antibiotic-resistant strains (e.g., Methicillin-resistant Staphylococcus aureus (MRSA)). Facultative and obligate intra cellular bacteria. Mechanisms of survival inside host cells, challenges in immune response, and advanced diagnostic techniques (e.g., PCR, CRISPR diagnostics). 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. Viral Immune Evasion: Mechanisms of immune evasion and diagnostic approaches using next-generation sequencing (NGS). Overview of Humoral and Cell mediated immune responses against the pathogens.

UNIT III CLINICAL IMMUNOLOGY 12

Disease caused by immune response – hypersensitivity, immune tolerance and autoimmunity- Auto immunity and auto immune disease: (a)Organs specific autoimmune disease- Hashimoto's thyroiditis, Good pastures syndrome, Insulin dependent diabetes mellitus, Grave's disease, Myasthenia gravis (b)Systemic autoimmune disease- SLE, Multiple sclerosis and Rheumatoid arthritis. Immunosuppression and Immunomodulation. Tumor immunology: Oncogene and cancer induction, Tumor antigens, Immune response to tumors, relation between tumor type and nature of immune response; Angiogenesis and tumor metastasis; anti-tumor drug resistance; immunotherapy.

UNIT IV IMMUNODIAGNOSIS 12

Diagnostic Immunology - Methods based on precipitation - Precipitation reaction, Immunodiffusion methods- SRID, ODD. Immunoelectrophoresis - Rocket and Counter current electrophoresis. Methods based on Agglutination- Haemagglutination – Haemagglutination inhibition. Labeled Assay- Immunofluorescence assay, Radio immunoassay, FISH, ELISA. Artificial Intelligence in Immunodiagnostics: Role of AI and machine learning in data interpretation for more accurate diagnostics.

UNIT V VACCINES **12**

Introduction to Vaccines and Adjuvants - Types of vaccines – Whole cell - Killed and Live Attenuated vaccines. Reverse vaccinology. 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 Hours

Course Outcome:

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

CO1: Recall the key concepts in immunology.

CO2: Explain the molecular and cellular mechanisms of immune responses.

CO3: Discuss the applications of immunodiagnostic techniques and assays.

CO4: Appraise the concepts of vaccine design, production, and efficacy.

CO5: Elaborate on the immunological basis of diseases and therapeutic applications.

CO6: Evaluate the ethical considerations in immunological practices.

CO7: Explain the strategies involved in the development of vaccines and clinical trials.

Text Books:

1. AK Abbas, AH Lichtman, & S Pillai, (2018), Cellular and Molecular Immunology, 9th Ed., Elsevier.
2. K Murphy, C Weaver & LJ Berg, (2016), Janeway's Immunobiology, 9th Ed., Garland Science.

Reference Books:

1. JV Ravetch & S Bolland, (2018), Immunology of the Immune System, 3rd Ed., Oxford University Press.
2. MF Flajnik & M Kasahara, (2016), The Evolution of the Immune System, Springer.

3. CR Mackay & UH von Andrian, (2017), T Cells: A Beginner's Guide, Oxford University Press.
4. JG Breman & B Aylward, (2016), The Global Vaccine Initiative, Springer.

Web Sources:

1. https://biologicalproceduresonline.biomedcentral.com/articles/10.1186/s12575-020-00135-3
2. https://www.slideshare.net/slideshow/1introduction-to-immunologyppt/259727926
3. https://www.walshmedicalmedia.com/open-access/reverse-vaccinology-basics-and-applications-2157-7560.1000194.pdf
4. https://www.cancer.gov/about-cancer/treatment/types/immunotherapy
5. https://www.msdmanuals.com/home/cancer/prevention-and-treatment-of-cancer/immunotherapy-for-cancer

24CMIM32 MEDICAL VIROLOGY

L	T	P	O	C
4	0	0	2	4

COURSE OBJECTIVE:

The candidates will understand the virus structure, classification, replication, pathogenesis, immune response, diagnostics, epidemiology, and control measures of viruses that cause diseases in humans. Successful completion of the course will give a solid understanding of the field of Virology and explore significant human viral pathogens and their impact on global health.

UNIT- I INTRODUCTION TO MEDICAL VIROLOGY 12

General properties of viruses, Viral nomenclature, Viral symmetry, Genome organization of viruses. Viral replication strategies - Attachment, entry, synthesis of macromolecules, maturation, release. Bacteriophages- Introduction, replication- lytic and lysogenic cycles. Viroids, Prions, Virusoids and Satellite RNA.

UNIT-II PATHOGENESIS, LAB DIAGNOSIS, CONTROL AND PREVENTION OF VIRAL INFECTIONS 12

Pathogenesis of virus; Transmission of virus- Route of entry, modes of transmission. Tissue tropism, evasion of host response, latency, persistence, transformation. Acute and persistent infections. Lab diagnosis; Specimen collection, transport and processing. Cultivation of virus, Microscopy, Serology, Molecular methods. Antiviral agents- Types and mode of action of antiviral agents. Vaccines- types and properties

UNIT-III HUMAN VIRUSES – I 12

General properties, antigenic structure, pathogenesis, clinical findings, prevention, control and treatment of Picornaviridae- Enterovirus, Rhinovirus, Hepatitis A virus. Togaviridae- Rubellavirus. Flaviviridae- Flavivirus, Hepatitis C virus. Coronaviridae

UNIT – IV HUMAN VIRUSES – II 12

General properties, antigenic structure, pathogenesis, clinical findings, prevention, control and treatment of Paromyxoviridae- Parainfluenza virus, Mumps virus, measles virus. Orthomyxoviridae- Orthomyxovirus. Retroviridae- Human Immunodeficiency virus

UNIT– V HUMAN VIRUSES- III 12

General properties, antigenic structure, pathogenesis, clinical findings, prevention, control and treatment of Herpesviridae- Herpes simplex virus, Varicella zoster virus. Poxviridae- Poxvirus. Hepadnaviridae- Hepatitis B virus, Hepatitis D virus. Oncogenic viruses.

Total: 60 Hours

Course Outcome:

At the end of this course students will be able to:

CO1: Understand the structure, classification, and replication of virus

CO2: Explain the pathogenesis of viruses

CO3: Illustrate the viral diagnostic techniques

CO4: Assess vaccine strategies

CO5: Distinguish the mechanisms of antiviral drugs

CO6: Elaborate the Pathogenesis of viral infections

CO7: Discuss specific human viral pathogens and their clinical implications

Text Books:

1. J Flint, RV Racaniello, GF Rall, T Hatziioannou, AM Skalka, (2020), Principles of Virology, 5th Ed. Wiley Publishers.

Reference Books:

1. CJ Burrell, CR Howard, FA Murphy, (2017), Fenner and White's Medical Virology, 5th Ed Academic Press.
2. DD Richman, RJ Whitley, FG Hayden, (2016), Clinical Virology; Wiley Publishers.
3. J Flint, VR Racaniello, GF Rall, T Hatziioannou & AM Skalka, (2020). Principles of Virology, Volume 1: Molecular biology (Vol. 1). John Wiley & Sons.
4. WWC Topley & GS Wilson, (2007). Topley & Wilson's Microbiology & Microbial infections. 10th Edn, Wiley- Blackwell Publishing Inc.
5. DD Richman, RJ Whitley & FG Hayden, (Eds.). (2020). Clinical virology. John Wiley & Sons.
6. R Ananthnarayanan & CKJ Panicker, (2020), Textbook of Microbiology, 11th Ed, Orient Longman.
7. E Jawetz. JL Melnick, EA Adelberg, (2019), Review of Medical Microbiology, 28th Ed. Lange Medical Publications, ELBS, London.

24CMIM33 IMMUNOTECHNOLOGY

L	T	P	O	C
4	0	0	2	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 ADVANCED ANTIGEN-ANTIBODY REACTIONS AND IMMUNOLOGICAL ASSAYS 12

Antigen-Antibody interactions: Latest developments in reaction mechanisms. Precipitation reactions and their modern applications in diagnostics. Advanced Immunodiffusion methods: SRID, ODD, and next-generation immunodiffusion. Modern Agglutination reactions: Rapid diagnostics, point-of-care testing applications. Electro-Immunodiffusion techniques: Rocket immunoelectrophoresis, countercurrent immunoelectrophoresis, Immunofixation. Application of surface plasmon resonance (SPR) and biolayer interferometry (BLI) in antigen-antibody interaction studies

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. Quantification techniques: Spectrophotometry, SDS-PAGE, and advanced proteomics tools (LC-MS/MS).

UNIT III MOLECULAR ENGINEERING 12

Molecular engineering: CRISPR-Cas9 applications in immunology. Antigen engineering for enhanced immunogenicity and novel vaccine development (mRNA vaccines, nanoparticle vaccines).Antibody engineering: Hybridoma Technology, recombinant DNA technology for antibody development. Humanized antibodies, chimeric antibodies, and bispecific antibodies. Applications in immunotherapy: Immune checkpoint inhibitors, therapeutic monoclonal antibodies. Personalized immunotherapies and global challenges.

UNIT IV IMMUNOASSAYS AND IMMUNOTHERAPY 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. Passive immunization, activation of NK cells, T Cells, generation of antibody. Emerging fields: Single-cell RNA sequencing for immune profiling. Ethical and regulatory considerations in immunotherapy.

UNIT V 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. Applications in translational immunology: Diagnostics, drug discovery, and precision medicine.

Total: 60 Hours

Course Outcome:

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

CO1: Understanding the principles in immunotechnology, point of care testing methods.

CO2: Elaborate on the advanced techniques employed in the purification of immunoglobulins.

CO3: Explain the principles involved in the production and characterization of antibodies

CO4: Discuss the applications of immunoassays and immunotherapeutics.

CO5: Appraise the molecular engineering of antibodies and immuno-molecules.

CO6: Elaborate on the methods for Vaccine Development.

CO7: Explain the ethics and regulations for immunotherapy and precision medicine.

Text Books:

1. AK Abbas, AH Lichtman & S Pillai, (2018), Cellular and Molecular Immunology, 9th Ed., Elsevier.

Reference Books:

1. JV Ravetch & S Bolland, (2018), Immunology of the Immune System, 3rd Ed., Oxford University Press.
2. MF Flajnik & M Kasahara, (2016), The Evolution of the Immune System, Springer.
3. CR Mackay & UH von Andrian, (2017), T Cells: A Beginner's Guide, Oxford University Press. Publications.
4. CA Janeway & P Travers, (2018), Immunobiology, 10th Ed., Garland Science.

Web Sources:

1. https://www.slideshare.net/slideshow/1introduction-to-immunologyppt/259727926
2. https://www.slideshare.net/slideshow/immunology-and-immunotechnology- notepptx/266120468
3. https://ocw.mit.edu/courses/hst-176-cellular-and-molecular-immunology-fall-2005/pages/lecture-notes/
4. https://pmc.ncbi.nlm.nih.gov/articles/PMC8282508/
5. https://moodle.riversideonline.com/pluginfile.php/5950/mod_resource/content/1/Chemotherapy%20and%20Immunotherapy%20Guidelines%20ebook.pdf

24PMIM31 PRACTICAL – CLINICAL IMMUNOLOGY AND IMMUNOTECHNOLOGY

L	T	P	O	C
0	0	4	1	2

COURSE OBJECTIVE:

The candidate will gain hands-on knowledge and acquire adequate skill required to perform precipitation reactions and purify immunoglobulins and detect antigens. The candidate will gain knowledge about immunological against infections; humoral and cell mediated immunity; autoimmunity mechanisms and damage; immunodiagnostic tests and assays.

1. Total and Differential Blood count
2. Single Radial Immunodiffusion
3. Ouchterlony double diffusion
4. Rocket immunoelectrophoroesis
5. Crossed Immunoelectrophoresis
6. Counter Immunoelectrophoresis
7. Electroimmunodiffusion
8. ELISA for HBs Antigen
9. Western Blot analysis for HIV

Total: 60 Lab Hours

Course Outcome:

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

CO1: Perform the counts of RBCs and WBCs.

CO2: Demonstrate the reaction between antigens and antibodies in gels.

CO3: Evaluate immune responses in health and disease by interpreting immunological experimental data.

CO4: Perform ELISA test for the detection of antigens.

CO5: Perform western blotting analysis for the diagnosis of infections.

CO6: Discuss effectively with multidisciplinary teams in laboratory settings, leadership skills, teamwork, and effective communication in scientific inquiry.

CO7: Develop skills in the development and optimization of immunological assays, including troubleshooting and quality control measures.

Reference Books:

1. FC Hay, OMR Westwood, (2005), Practical Immunology, EPZ Ed, Wiley-Blackwell
2. R Pabst, (2018), Immunology: A Short Course, 9th Ed., Wiley-Blackwell
3. AW Gowenlock & W McMurray, (2015), Varley's Practical Clinical Biochemistry, 8th Ed., Heinemann Medical.
4. R Lester & M Walport, (2016), Clinical Immunology and Immunopathology, Elsevier.
5. M Mann & M Reinders, (2016), Handbook of Protein Chromatography and Conjugation, Elsevier.

24DMIM31 MEDICAL MYCOLOGY AND PARASITOLOGY

L	T	P	O	C
4	0	0	2	4

COURSE OBJECTIVE:

The candidate will understand the pathogenic mechanisms, clinical presentations, conventional diagnosis, recent advancements and treatment of medically important fungi and parasites.

UNIT- I INTRODUCTION TO MYCOLOGY 10

Classification of fungi. Morphology of fungi. Growth and reproduction in fungi. Virulence factors. Pathogenesis, lab diagnosis and treatment of fungal infections. Antifungal agents. Antifungal susceptibility testing. Mechanism of antifungal resistance. Recent advances in fungal diagnosis

UNIT-II MYCOSES 14

Superficial Mycoses- Dermatophytosis, Dermatomycosis. Subcutaneous Mycoses- Mycetoma, Sporotrichosis, Chromoblastomycosis, Phaeohypomycosis, Rhinosporidiosis. Systemic mycoses- Histoplasmosis, Blastomycosis, Coccidiodomycosis and Paracoccidiodomycosis. Opportunistic mycoses-Candidiasis, Cryptococcosis, Aspergillosis, Zygomycosis, Penicilliosis, Dimatiaceous fungi.

UNIT-III INTRODUCTION TO PARASITOLOGY 11

Host-parasite relationship. Classification of parasites. Cultivation of parasites. Lab diagnosis of parasitic infections, Recent advancements in diagnosis of parasitic infections. Pathogenesis, transmission, lifecycle, diagnosis and treatment of protozoans- *Entamoeba, Giardia, Trichomonas, Balantidium, Acanthamoeba, Naegleria.*

UNIT – IV HAEMOFLAGELLATES 10

Pathogenesis, transmission, lifecycle, diagnosis and treatment of Trypanosomes- *Leishmania, Trypanosoma*, Sporozoites- *Plasmodium*. Coccidia- *Toxoplasma, Cryptosporidium*

UNIT– V HELMINTHS 15

Pathogenesis, transmission, lifecycle, diagnosis and treatment of Cestodes – *Taenia, Echinococcus*. Trematodes – *Fasciola, Fasciolopsis, Paragonimus, Schistosoma*. Nematodes – *Ascaris, Ancylostoma, Trichinella, Trichuris, Strongyloides, Enterobius*, Filarial worms- *Wucheriria, Brugia, Loa loa.*

Total: 60 Hours

Course Outcome:

At the end of this course students will be able to:

CO1: Classify medically important fungi

CO2: Summarize the different classes of antifungal agents and their resistance mechanisms

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

CO4: Classify medically important parasites

CO5: Elaborate the interactions between the host and the parasite

CO6: Determine how to cultivate parasites

CO7: Perceive the Pathogenesis, Clinical manifestation, Laboratory diagnosis and treatment of various parasites

Text Books:

1. KD Chatterjee, (2019), Medical Parasitology, 13th Edn, CBS Publishers.
2. J Chandar, (2018), A textbook of Medical Mycology, 4th Edn, Jaypee Brothers Medical Publishers.

Reference Books:

1. D.R. Arora & B.R. Arora (2018), Medical Parasitology, 5th Edn, CBS Publishers.
2. SC Parija, (2013), Textbook of Medical Parasitology, 4th Edn, All India Publishers and Distributors.
3. J Panicker, (2018), Textbook of Parasitology, 8th Edn, C.K. Jaypee Brothers.
4. GD Schmidt & LS Roberts, (2009), Foundations of Parasitology, 8th Edn, The McGraw Hill Companies Inc.
5. CJ Alexopoulos, (2007), Introductory Mycology, 4th Edn, Wiley and Sons.
6. HC Dube, (2012), An introduction to Fungi, 4rd Edn, Scientific Publishers.
7. CJ Alexopoulos & HC Bold (2001), Algae & Fungi. MacMillan & Co Ltd, London.
8. KS Bilgrami, RN Verma, (2011), Physiology of Fungi, 3rd Edn, Scientific Publishers.

24DMIM32 BIOINFORMATICS IN MICROBIOLOGY

L	T	P	O	C
3	0	0	2	3

COURSE OBJECTIVE:

This course aims to introduce students to the fundamental principles of bioinformatics and its applications in microbiology. Students will gain an understanding of computational tools and biological databases that are essential for analyzing microbial genomes, proteins, and metabolic pathways. By learning how to retrieve, process, and interpret biological data, they will develop skills to explore microbial diversity and genetic variations effectively.

UNIT- I INTRODUCTION TO BIOINFORMATICS & COMPUTATIONAL BIOLOGY 9

Overview of Bioinformatics: Definition, scope, and applications in microbiology, Biological Databases: NCBI, EMBL, DDBJ, UniProt, PDB, KEGG, and their significance, Sequence Data Formats: FASTA, GenBank, ClustalW, Basic Bioinformatics Tools: BLAST, FASTA, ClustalW/X, Introduction to Computational Biology: Role in microbial genomics.

UNIT-II GENOMICS AND PROTEOMICS IN MICROBIOLOGY 9

Microbial Genomics: Genome sequencing techniques (Sanger, NGS, Nanopore), Genome Annotation & Comparative Genomics, Metagenomics: Applications in microbial diversity analysis, Microbial Proteomics: Protein structure, function, and interaction databases

Protein Sequence and Structure Prediction.

UNIT-III PHYLOGENETICS AND EVOLUTIONARY BIOLOGY 9

Concepts of Molecular Evolution Multiple Sequence Alignment Tools: ClustalW, MUSCLE, T-Coffee, Microbial Taxonomy and Evolutionary Relationships, Application of Phylogenetics in Disease Surveillance

UNIT – IV STRUCTURAL BIOINFORMATICS & SYSTEMS BIOLOGY 9

Protein Structure Prediction: Homology modeling, ab initio methods, Molecular Docking & Drug Discovery: AutoDock, SwissDock, molecular dynamics. Microbial Pathway Analysis: KEGG pathways, metabolic network analysis. Systems Biology in Microbial Studies: Interactions, synthetic biology approaches. CRISPR and Genome Editing: Role in microbiology and biotechnology

UNIT– V APPLICATIONS OF BIOINFORMATICS IN MICROBIOLOGY 9

Microbial Drug Resistance Prediction, Microbiome Analysis & Metagenomics Tools: QIIME, MG-

RAST, Vaccine Design & Immunoinformatics. AI & Machine Learning in Microbial Bioinformatics. Case Studies: Bioinformatics in Public Health and Epidemiology

Total: 45 Hours

Course Outcome:

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

CO1: Recall key bioinformatics databases, tools, and computational techniques used in microbial research.

CO2: Explain the principles of microbial genomics, proteomics, and metagenomics, and their significance in microbiological studies.

CO3: Analyze microbial genomes, perform sequence alignments, and construct phylogenetic trees for evolutionary studies.

CO4: Examine microbial metabolic pathways, molecular docking results, and systems biology approaches to interpret complex biological interactions.

CO5: Compare different computational methods, and critically analyze microbial resistance patterns.

CO6: Develop bioinformatics-driven approaches for solving microbiological challenges.

CO7: Synthesize bioinformatics concepts with microbiological applications.

Text Books:

1. R Krenkel, M Lurscher & R Daniel (2023), Introduction to Bioinformatics in Microbiology, 2nd Edition, Springer, Cham.

Reference Books:

10. D MacLean, (2023), Bioinformatics Cookbook - Second Edition: Utilize R packages for bioinformatics, genomics, data science, and machine learning, Packt Publishing, Birmingham.

11. M Arthur, M. Lesk (2019), Introduction to Bioinformatics, 5th Edition, Oxford University Press, Oxford.

12. J Pevsner (2015), Bioinformatics and Functional Genomics, 3rd Edition, Wiley-Blackwell, Hoboken.

13. BE Dutilh (2019), Exploring Microbial Community Structure and Function in Microbiomes, Springer,

Cham.

Web Sources:

10. https://microbenotes.com/category/bioinformatics/?utm_source=chatgpt.com
11. https://ocw.mit.edu/courses/6-092-bioinformatics-and-proteomics-january-iap-2005/pages/lecture-notes/?utm_source=chatgpt.com

24DMIM33 RECOMBINANT DNA TECHNOLOGY

L	T	P	O	C
3	0	0	2	3

COURSE OBJECTIVES:

The candidates will understand rDNA technology and strategies involved in genetic manipulations. Evaluate different types of vectors used in genetic engineering, their characteristics, and applications in various organisms. Explore methods of gene transfer, both physical and chemical, and their applications in different biological systems, alongside selection strategies for recombinant clones and applications in various fields.

UNIT I INTRODUCTION TO RECOMBINANT DNA TECHNOLOGY 9

Milestones in genetic engineering and biotechnology. Tools of Recombinant DNA Technology. Definition of gene manipulation - Major steps involved in gene cloning - Isolation and Purification of Chromosomal and Plasmid DNA, Isolation and Purification of RNA DNA modifying enzymes. Agarose gel electrophoresis and SDS – PAGE. Pulse field electrophoresis for large DNA.

UNIT II VECTORS 9

Definition and importance of vectors in genetic engineering, Characteristics of an ideal vector, cloning vectors – Plasmids, phages, Cosmids, Phagemids, Artificial chromosomal vectors, Shuttle vectors; Viral Vectors, Expression Vectors, choice of vectors for *E. coli*, fungi, higher plants and mammalian cells.

UNIT III GENE TRANSFER 9

Definition and significance of gene transfer methods. Physical Methods- Electroporation, Microinjection, Particle Bombardment (Bioballistics), Chemical Methods - Calcium Phosphate Transfection, Liposome-Mediated Transfection, Polyethyleneimine (PEI) Transfection. Viral Methods of Gene Transfer, Bacterial Methods of Gene Transfer, Plant-Specific Gene Transfer Methods, Agrobacterium-Mediated Transformation.

UNIT IV SELECTION OF RECOMBINANTS 9

Strategies for obtaining the clone of choice- Direct selection – selection from gene library. Construction of DNA libraries. Screening of recombinants- Insertional inactivation and complementation, blue-white screening, immunodetection and radioactive probes. Uses of cloning in medicine, agriculture, forensic science and industries. Socio-economic ethics of cloning, GEO, GMF.

UNIT V: MOLECULAR TECHNIQUES AND ANALYSIS - DNA TO PROTEINS 9

Blotting (Southern, Western, Northern) techniques – PCR - basic steps in DNA amplification, RAPD, RFLP and their applications – DNA finger printing - DNA microarray analysis. Analysis of protein – DNA and protein – protein interactions. Proteome analysis by 2D gel electrophoresis. Principles of MALDI – TOF and LC-MS platforms.

Total Hours: 45

Course Outcomes:

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

CO1: Explain the major steps in gene cloning and DNA manipulation.

CO2: Apply knowledge of different vector types and their characteristics to select appropriate vectors for genetic engineering applications in diverse organisms

CO3: Evaluate and compare various methods of gene transfer and justify their applications in different biological contexts.

CO4: Evaluate the impact of genetic engineering on global environmental and health policies.

CO5: Develop strategies for selecting recombinants, including direct selection and screening techniques like blue-white screening and immunodetection.

CO6: Utilize strategies for obtaining specific clones, including construction of DNA libraries and screening techniques.

CO7: Apply molecular techniques from DNA to protein analysis.

Textbook:

1. R.C. Dubey & D.K. Maheshwari (2022), A Textbook of Biotechnology, S. Chand Publishing. Ed. 5.

Reference Books:

1. T.A. Brown (2020), Gene Cloning and DNA Analysis: An Introduction, Wiley-Blackwell. Ed. 7.
2. L. Smith (2021), Essential Molecular Biology: A Practical Approach, Oxford University Press. Ed. 2.
3. M. Spector & D. Mahalingam (2021), Molecular Genetics: Principles and Practice, Garland Science. Ed. 1.
4. S.J. Higgins & P. Smith (2022), Molecular Biotechnology: Principles and Applications of Recombinant DNA, Pearson Education. Ed. 4.
5. K.J. Stokstad & L.J. Langer (2023), Advanced Molecular Biology Techniques, Elsevier. Ed. 1.

Web Sources:

1. https://www.britannica.com/science/recombinant-DNA-technology
2. https://microbenotes.com/recombinant-dna-technology-steps-applications-and-limitations/

24DMIM34 MEDICAL BIOTECHNOLOGY

L	T	P	O	C
3	0	0	2	3

COURSE OBJECTIVE:

The objective of the Medical Biotechnology course is to equip students with a comprehensive understanding of biotechnological techniques applied to medicine. It aims to explore the role of biotechnology in drug development, diagnostics, and personalized medicine. Students will gain insights into genetic engineering, molecular diagnostics, and therapeutic innovations. The course also emphasizes the ethical, regulatory, and social aspects of biotechnology in healthcare.

UNIT- I INTRODUCTION TO MEDICAL BIOTECHNOLOGY 9

Definition, scope, and applications of biotechnology in medicine. Ethical, legal, and social issues in medical biotechnology. Overview of biotechnological tools and techniques. DNA sequencing, PCR, and gel electrophoresis. .Recombinant DNA technology and cloning. Genomic and proteomic analysis. Gene editing technologies (CRISPR-Cas9). Gene therapy and its applications. Stem cell technology in medical treatments.

UNIT-II BIOTECHNOLOGY IN DRUG DEVELOPMENT 9

Phases of drug development. Biotech companies and drug pipelines. Regulatory aspects in drug approval (FDA, EMA). Molecular Targets in Drug Design. Enzyme inhibitors, receptors, and ion channels. Structure-activity relationships (SAR). High-throughput screening and drug discovery. Production of therapeutic proteins using recombinant DNA technology. Monoclonal antibodies and their clinical applications. Types of vaccines: DNA, RNA, protein subunit vaccines

Vaccine delivery systems and adjuvants

UNIT-III DIAGNOSTIC BIOTECHNOLOGY 9

Importance of biotechnology in diagnostics. Types of diagnostic tests (genetic, immunodiagnostic, microbiological). Polymerase Chain Reaction (PCR), RT-PCR, and qPCR

DNA microarrays and their applications. Next-generation sequencing (NGS) in diagnostics. Enzyme-linked immunosorbent assay (ELISA). Lateral flow assays and point-of-care diagnostics. Monoclonal antibodies in diagnostics

UNIT – IV BIOTECHNOLOGY IN PERSONALIZED MEDICINE 9

Concept of personalized medicine and pharmacogenomics. Role of biotechnology in personalized healthcare. Next-generation sequencing (NGS). Whole-genome sequencing and its implications. Epigenomics in disease understanding and therapy. Identification and validation of biomarkers. Role of

biomarkers in diagnosis and prognosis

Companion diagnostics for personalized treatment.

UNIT– V CLINICAL BIOTECHNOLOGY 9

Definition and importance of biosafety in biotechnological research. Types of Biological Risks. Pathogenic microorganisms, genetically modified organisms (GMOs), and biohazards. Risk assessment strategies in biotechnology. Stem cell biology and applications in tissue repair. Gene therapy and cell therapy for clinical applications. Scaffold-based tissue engineering.

Total: 45 Hours

Course Outcome:

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

CO1: Recall and describe key concepts in medical biotechnology, including its applications in diagnostics, therapeutics, and drug development.

CO2: Explain the principles and mechanisms behind molecular biology techniques such as PCR, gene cloning, and DNA sequencing, and their relevance in medical research.

CO3: Apply genetic engineering techniques to address genetic disorders and develop potential therapeutic solutions.

CO4: Analyze biopharmaceutical production processes, focusing on recombinant proteins and monoclonal antibodies, and assess their clinical applications in medical treatments.

CO5: Evaluate and interpret bioinformatics data from genetic and protein analysis, using relevant tools to solve problems in drug discovery and personalized medicine.

CO6: Design and propose innovative biotechnology-based therapeutic approaches, considering ethical, regulatory, and societal implications in clinical applications.

CO7: synthesize knowledge from various aspects of biotechnology to critically assess emerging technologies, providing informed insights into their impact on healthcare and medical research.

Textbook:

5. A. K. Gupta and P. G. Rathi (2017), Medical Biotechnology: Techniques and Applications, 1st edn, Wiley-India, New Delhi, India.
6. W. S. Robinson and J. K. Walker (2018), Medical Biotechnology: Principles and Applications, 2nd edn, Springer, Cham, Switzerland.

Reference Books:

3. B. J. Campbell, L. L. K. Trivett, and C. E. Redman (2017), Biotechnology and Biosafety: A Practical Guide, 1st edn, Wiley-Blackwell, Hoboken, NJ.
4. M. P. Doyle and L. K. T. F. Buckley (2016), Medical Biotechnology: Advanced Topics in Molecular Medicine, 3rd edn, CRC Press, Boca Raton, FL.

Web Sources:

1. https://www.stuvia.com/doc/2438034/medical-biotechnology-lecture-notes?utm_source=chatgpt.com
2. https://www.studocu.com/en-us/document/university-of-north-carolina-at-charlotte/intro-to-biotechnology/14-medical-biotechnology-notes/3204875?utm_source=chatgpt.com

24SSKP13 **SOFT SKILLS III**

L	T	P	O	C
2	0	0	1	2

COURSE OBJECTIVE:

- To enable students to develop their soft skills and Body Language
- To enhance students Reading, Writing, Listening and Speaking skills
- To develop their self-confidence to excel at Interviews

UNIT–I **06**

Powerful Presentation

UNIT–II **06**

Reinforcement

UNIT–III **06**

Using visual aids

UNIT–IV **06**

Types and Methods of Presentations

UNIT–V **06**

Obstacles to Presentation

Total: 30 Hours

Course Outcome:

CO1 To develop participants social and professional skills

CO2 To help participants manage time effectively

CO3 To build a strong resume to suit corporate requirements

CO4 To face interviews confidently

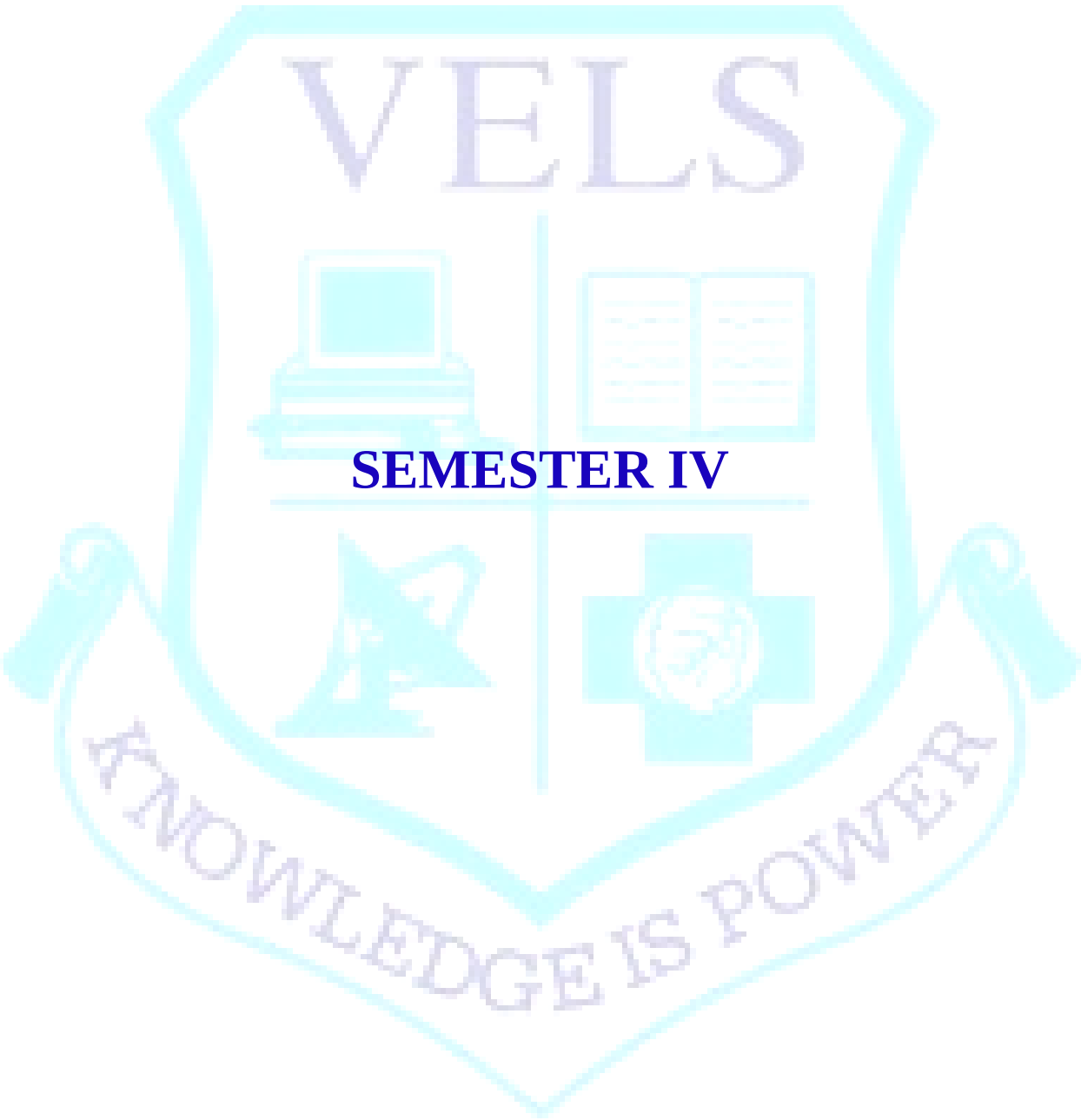
CO5 To enhance their aptitude abilities

Textbook:

- Roz Townsend: Presentation Skills for the Upwardly Mobile, Emerald, Chennai.
- Prasad, H. M. How to Prepare for Group Discussion and Interview. New Delhi: Tata McGraw-Hill Publishing Company Limited, 2001.
- Pease, Allan. Body Language. Delhi: Sudha Publications, 1998.

Web Sources:

- https://www.skillsyouneed.com/ips/communication-skills.html
- https://venngage.com/blog/presentation-skills/
- https://gdpi.hitbullseye.com/Group-Discussion.php



SEMESTER IV

24DMIM41 **CYBER SECURITY**

L	T	P	O	C
3	0	0	2	3

COURSE OBJECTIVE

To introduce students to the fundamental concepts and evolving landscape of cyber security, including cyber threats, cyber warfare, and critical infrastructure protection.

To provide in-depth knowledge about various types of cyber crimes, cyber law frameworks, and enforcement mechanisms both in India and globally.

To equip students with an understanding of data privacy, data protection regulations, and effective cyber security management strategies including compliance and governance.

UNIT I OVERVIEW OF CYBER SECURITY **9**

Cyber security increasing threat landscape, Cyber security terminologies- Cyberspace, attack, attack vector, attack surface, threat, risk, vulnerability, exploit, exploitation, hacker., Non-state actors, Cyber terrorism, Protection of end user machine, Critical IT and National Critical Infrastructure, Cyberwarfare, Case Studies

UNIT II CYBER CRIMES **9**

Cyber crimes targeting Computer systems and Mobiles- data diddling attacks, spyware, logic bombs, DoS, DDoS, APTs, virus, Trojans, ransomware, data breach., Online scams and frauds- email scams, Phishing, Vishing, Smishing, Online job fraud, Online sextortion, Debit/ credit card fraud, Online payment fraud, Cyberbullying, website defacement, Cybersquatting, Pharming, Cyber espionage, Cryptojacking, Darknet- illegal trades, drug trafficking, human trafficking., Social Media Scams & Frauds- impersonation, identity theft, job scams, misinformation, fake newscyber crime against persons - cyber grooming, child pornography, cyber stalking., Social Engineering attacks, Cyber Police stations, Crime reporting procedure, Case studies.

UNIT III CYBER LAW **9**

Cyber crime and legal landscape around the world, IT Act,2000 and its amendments. Limitations of IT Act, 2000. Cyber crime and punishments, Cyber Laws and Legal and ethical aspects related to new technologies- AI/ML, IoT, Blockchain, Darknet and Social media, Cyber Laws of other countries, Case Studies.

UNIT IV DATA PRIVACY AND DATA SECURITY **9**

Defining data, meta-data, big data, nonpersonal data. Data protection, Data privacy and data security, Personal Data Protection Bill and its compliance, Data protection principles, Big data security issues and challenges, Data protection regulations of other countries- General Data

Protection Regulations(GDPR),2016 Personal Information Protection and Electronic Document Act (PIPEDA)., Social media- data privacy and security issues.

UNIT V CYBER SECURITY MANAGEMENT, COMPLIANCE AND GOVERNANCE

Cyber security Plan- cyber security policy, cyber crises management plan., Business continuity, Risk assessment, Types of security controls and their goals, Cyber security audit and compliance, National cyber security policy and strategy.

Total Hours 45

COURSE OUTCOME

CO1: To explain the key terminologies, threat vectors, and actors in the cyber security landscape.

CO**2: To** analyze various forms of cybercrimes and demonstrate awareness of online frauds, scams, and social engineering techniques.

CO3: To apply the relevant cyber laws and legal provisions applicable to different types of cyber offenses including AI, IoT, Blockchain and social media.

CO4: To assess data privacy concerns and apply global data protection regulations such as GDPR and PIPEDA in real-world scenarios.

CO5: To design basic cybersecurity frameworks for organizations including security policies, risk assessments, and cyber crisis management plans.

TEXTBOOK/REFERENCES

1. Cyber Security Understanding Cyber Crimes, Computer Forensics and LegalPerspectives by Sumit Belapure and Nina Godbole, Wiley India Pvt. Ltd.
2. Information Warfare and Security by Dorothy F. Denning, Addison Wesley.
3. Security in the Digital Age: Social Media Security Threats and Vulnerabilities byHenry A. Oliver, Create Space Independent Publishing Platform.
4. Data Privacy Principles and Practice by Natraj Venkataramanan and Ashwin Shriram,CRC Press.
5. Information Security Governance, Guidance for Information Security Managers byW. KragBrothy, 1st Edition, Wiley Publication.
6. Auditing IT Infrastructures for Compliance By Martin Weiss, Michael G. Solomon,2nd Edition, Jones Bartlett Learning.

24CMIM41 ENVIRONMENTAL MICROBIOLOGY

L	T	P	C
4	0	0	4

COURSE OBJECTIVE:

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 12

Microbiology of air; droplet, droplet nuclei, aerosol, infectious dust. Assessment of air quality. Laboratory hazards of air microbes, airborne diseases, air sanitation. Sources and Transport of Airborne Microorganisms

UNIT-II AQUATIC MICROBIOLOGY 12

Aquatic Microbiology- aquatic ecosystems- freshwater (ponds, lakes, streams), marine ecosystem (estuaries, mangroves, deep sea, coral reef); Eutrophication. Microbial Diversity in Aquatic Systems. Assessment of water quality - Physical (TSS, TDS); Chemical (BOD, COD, salinity, pH); Biological (Fecal coliform).

UNIT-III WASTEWATER MICROBIOLOGY 12

Wastewater Microbiology- types and characteristics of waste. Wastewater Treatment Technologies - Liquid waste treatment- primary, secondary, tertiary treatment, disinfection and disposal, Solid waste treatment-Incineration, landfill, composting. Water borne diseases- pathogenesis, prevention and control.

UNIT – IV MICROBES IN ECOSYSTEM 12

Microbial communities and role of microbes in the ecosystem (primary producers, consumers, decomposers, autotrophs and heterotrophs). Microbial Interactions. Adaptations of microbes in extreme environments- thermophile, psychrophile, halophile, acidophile, alkalophile, barophile, osmophile.

UNIT– V RECALCITRANCE AND BIOREMEDIATION 12

Bioremediation – In situ and ex situ. Recalcitrance and biodegradation of recalcitrant compounds. Biodegradation of xenobiotic compounds. Bioaccumulation of heavy metals, biomagnification, biocorrosion, bioleaching and bio mining.

Total: 60 Hours

Course Outcome:

At the end of this course students will be able to:

CO1: Understand the diversity and ecology of microorganisms in aquatic environments.

CO2: To recognize the ecological problems caused by air pollution and design methods to evaluate the human impacts as well as environmental protection.

CO3: Obtain detailed information on aquatic ecosystems and assess the water quality by various methods.

CO4: Analysis of current wastewater treatment methods.

CO5: Summarize the correct understanding of microbial interactions with environment.

CO6: Acquire knowledge on biodegradation, its types and learn to design the protocols for optimization of degradable parameters.

Text Books:

1. Ronald. M.Atlas, Richard Bartha, Microbial Ecology. Fundamental and applicationAn imprint of Addison Wesley LongmanInc. 4thed,1998.

Reference Books:

1. Joseph. C. Daniel, Environmental Aspects of Microbiology, Brightsun Publications. 2nd. Ed., 2006.
2. Dr.K.VijayaRamesh, Environmental Microbiology,MJPPublishers.1stEd, 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, NarosaPublicationsLimited.1stEd, 2005.
6. Edowrly.S, HardmanOJ and Wait S, Pollution: Ecology and Biotreatment, Longman Scientific Technical. 1993.
7. Baker KHand Herson OS, Bioremediation, McGraw Hill, NY. 1994.
8. R.C.Dubey and D.K.Maheswari, Practical Microbiology,S, Chand & Co Ltd, New Delhi. 1st ed, 2008.

Web Sources:

1. https://ocean.si.edu/ocean-life/invertebrates/corals-and-coral-reefs
2. https://gmch.gov.in/estudy/e%20lectures/Community%20Medicine/2018/WATER%20BORNE%20DISEASES.pdf
3. http://www.crystaltanks.com/sewage_treatment_explained.html
4. https://www.ijcmas.com/vol-4-6/S.K.%20Jha,%20et%20al.pdf
5. file:///C:/Users/Vignesh/Downloads/309-Article%20Text-616-1-10-20170325.pdf

24PMIM41 PRACTICAL – ENVIRONMENTAL MICROBIOLOGY

L	T	P	O	C
0	0	3	1	1

COURSE OBJECTIVE:

This course aims to train students in standard microbiological methods for assessing air, water, and soil quality. It provides hands-on skills in microbial enumeration, MPN analysis, membrane filtration, biomass estimation, and biosorption-based bioremediation. Students will learn to interpret environmental microbial data for pollution monitoring and ecosystem health assessment. Field and industrial visits reinforce real-world applications in treatment plants, coastal stations, and quality control laboratories.

1. Enumeration of microbes in air- Reuters Air sampler as per - BAM, APHA, IS Standards.
2. MPN for coliforms in water as per - BAM, APHA, IS Standards.
3. Enumeration of microbes in water using membrane filter.
4. Estimation of soil microbial biomass carbon (fumigation–extraction method)
5. Assessment of microbial bioremediation of heavy metals using biosorption assays.
   Field trip / Industrial visit to sewage treatment plants, effluent treatment plant, Coastal field stations of NIOT, CMFRI, ICAR-CIBA, Pharma QC labs, food industry QC, NABL labs, pollution monitoring stations, NEERI, CECRI, metallurgical industries.

Total: 30 Lab Hours

Course Outcome:

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

CO1: Students will be able to enumerate microorganisms in air, water, and soil using standard BAM, APHA, and IS procedures.

CO2: Students will perform MPN analysis and membrane filtration techniques to assess water quality and detect coliform contamination.

CO3: Students will estimate soil microbial biomass carbon using fumigation–extraction and interpret soil health indicators.

CO4: Students will evaluate microbial bioremediation potential through biosorption assays for heavy metal removal.

CO5: Students will analyze and interpret microbial data to assess environmental pollution and ecosystem quality.

CO6: Students will apply laboratory safety, aseptic techniques, and quality control standards in environmental microbiology experiments.

CO7: Students will gain practical exposure to environmental monitoring systems through field visits to STPs, ETPs, coastal research stations, QC labs, and industrial facilities.

Reference Books:

1. Cappuccino, J.G. & Sherman, N. *Microbiology: A Laboratory Manual*, Pearson.
2. Shumway, K.T. et al., *Environmental Microbiology Laboratory Manual*, Academic Press.

24DMIM42 MICROBIAL TECHNOLOGY FOR HUMAN WELFARE

L	T	P	O	C
4	0	0	2	4

COURSE OBJECTIVE:

This course explores the diverse applications of microorganisms in enhancing human welfare. It emphasizes microbial technologies in health, agriculture, industry, and the environment, showcasing their transformative role in addressing societal challenges.

UNIT- I INTRODUCTION TO MICROBIAL TECHNOLOGY 12

Overview of Microbial Technology- Historical development and modern advancements. Microbial Diversity- Types of microbes (bacteria, fungi, algae, viruses, and archaea) and their roles in nature. Microbial Genomics and Proteomics- Tools for understanding and utilizing microbial systems. Principles of Bioprocessing- Fermentation technology and downstream processing.

UNIT –II MICROBIAL APPLICATIONS IN MEDICINE 12

Antibiotics and Vaccines- Microbial sources, production, and advancements. Probiotics and Prebiotics- Role in gut health and disease prevention. Therapeutic Enzymes- Microbial production and applications. Phage Therapy-Bacteriophages as alternatives to antibiotics. Microbial Diagnostics-Biosensors and rapid detection technologies.

UNIT - III MICROBIAL TECHNOLOGY IN AGRICULTURE 12

Biofertilizers- Microbes enhancing soil fertility and plant growth**.** Biopesticides- Eco- riendly microbial solutions for pest control. Microbial Biostimulants-Promoting sustainable agriculture. Plant-Microbe Interactions- Rhizosphere dynamics and crop improvement. Genetically Engineered Microbes- Applications in agriculture.

UNIT - IV MICROBIAL CONTRIBUTIONS TO INDUSTRY AND ENVIRONMENT 12

Industrial Enzymes- Microbial production of amylase, protease, cellulase, and lipase. Bioplastics and Biopolymers-Microbial synthesis and applications. Bioremediation- Microbial cleanup of oil spills, heavy metals, and pollutants. Bioenergy- Microbial production of biogas, biodiesel, and bioethanol. Sustainable Waste Management- Microbes in recycling and composting.

UNIT - V ADVANCED MICROBIAL TECHNOLOGIES AND ETHICAL CONSIDERATIONS 12

Synthetic Biology- Engineering microbes for novel applications. CRISPR-Cas Technology-Applications in gene editing and microbial research. Microbial Nanotechnology- Innovations in medicine, agriculture, and environment. Regulatory Frameworks-Biosafety and bioethics in microbial applications. Future Directions- Emerging microbial technologies for global challenges.

Total: 60 Hours

Course Outcome:

By the end of this course, students will:

1. Understand the role of microbes in advancing human welfare.
2. Analyze microbial contributions to medicine, agriculture, industry, and the environment.
3. Develop skills to apply microbial technologies in real-world scenarios.
4. Explore innovative and ethical approaches to utilizing microbes for societal benefit.
5. Appreciate the potential of microbes in shaping a sustainable future.

Text Books:

1. Y. R. Girbane, S. Roy, N. S. Bhujbal and A. K. Patel (2024), A Comprehensive Text Book for Pharmaceutical Microbiology, Shashwat Publication, Bilaspur, India.

Reference Books:

1. P.K. Arora (2020), Microbial Technology for Health and Environment, Springer, Singapore.
3. I. Ahmad, F. Ahmad, and J. Pichtel (2011), Microbes and Microbial Technology: Agricultural and Environmental Applications, Springer, New York, NY.
4. N.K. Brahma (2010), Microbes, Microbial Engineering, and Technology, Nova Science Publishers, Hauppauge, NY.
5. R.C. Ray and C.M. Rosell (2017), Microbial Enzyme Technology in Food Applications, CRC Press, Boca Raton, FL.

24DMIM43 BIOENERGETICS IN MICROORGANISMS

L	T	P	O	C
4	0	0	2	4

COURSE OBJECTIVE:

The course on Bioenergetics in Microorganisms aims to provide students with a comprehensive understanding of the principles of energy generation and conservation in microorganisms. Students will explore the biochemical pathways of metabolism, including aerobic and anaerobic respiration, fermentation, and photosynthesis, while gaining insight into the mechanisms of energy transduction.

UNIT- I INTRODUCTION TO BIOENERGETICS AND THERMODYNAMICS IN MICROORGANISMS 12

Concept of Bioenergetics: Energy flow in biological systems, types of energy in biological reactions. Laws of Thermodynamics: First law: Conservation of energy Second law: Entropy and spontaneous processes. Gibbs free energy and its application in biological reactions. Energy Transduction in Microorganisms: Mechanisms of energy conversion within microbial cells.

UNIT-II METABOLISM AND ENERGY GENERATION IN MICROORGANISMS 12

Overview of Microbial Metabolism: Anabolism and catabolism. Aerobic Respiration in Microorganisms: Glycolysis, citric acid cycle, and oxidative phosphorylation. ATP synthesis and electron transport chain. Anaerobic Respiration and Fermentation: Anaerobic pathways in microorganisms: nitrate, sulfate, and fumarate reduction. Types of fermentation: alcoholic, lactic acid, mixed-acid, etc.

UNIT-III ELECTRON TRANSPORT CHAIN (ETC) AND PROTON MOTIVE FORCE 12

Structure and Function of the Electron Transport Chain: Components: NADH dehydrogenase, cytochrome b/c1 complex, cytochrome oxidase, etc. Role in generating the proton motive force (PMF). Proton Motive Force (PMF): Proton gradient and ATP synthesis. Role in energy coupling.

UNIT – IV ENERGY CONSERVATION IN PHOTOSYNTHETIC MICROORGANISMS 12

Photosynthesis in Microorganisms: Light-dependent and light-independent reactions (Calvin cycle). Photosynthetic pigments in microorganisms. Photophosphorylation: Cyclic and non-cyclic photophosphorylation. Comparison between oxygenic and anoxygenic photosynthesis in bacteria. Energy Efficiency in Microbial Photosynthesis.

UNIT–V REGULATION OF ENERGY METABOLISM IN MICROORGANISMS 12

Regulatory Mechanisms: Regulation of enzymes in metabolic pathways (feedback inhibition, allosteric regulation). Role of regulatory proteins in energy metabolism (e.g., FNR, ArcA in bacteria).Adaptation to Environmental Changes: Energy generation in response to oxygen availability, nutrient limitations, and stress conditions. Adaptive mechanisms like respiration-fermentation switch, nitrogen fixation in microorganisms.

Total: 60 Hours

Course Outcome:

At the end of this course students will be able to:

CO1: recall the fundamental concepts of bioenergetics, including key terms, thermodynamic laws, and energy flow in microbial systems.

CO2: Explain the biochemical processes of microbial metabolism, such as glycolysis, the citric acid cycle, oxidative phosphorylation, and fermentation.

CO3: Apply their knowledge of the electron transport chain and proton motive force to analyze energy transduction in microbial cells.

CO4: Differentiate between various types of microbial photosynthesis, including oxygenic and anoxygenic processes, and analyze their energy efficiency.

CO5: Evaluate the regulatory mechanisms that control microbial energy metabolism, such as enzyme regulation and adaptive responses to environmental stressors.

CO6: Design experimental setups to explore microbial energy generation under different environmental conditions, integrating knowledge of energy pathways and regulation.

CO7: Integrate concepts of microbial bioenergetics into real-world applications.

Text Books:

1. R. Chakrabarty, (2018), Microbial Physiology and Metabolism, 2nd edition, Oxford University Press, New Delhi.

Reference Books:

1. D.L. Nelson, M.M. Cox (2017), Lehninger Principles of Biochemistry, 7th edition, W.H. Freeman and Company, New York.
2. K. Wilson, J. Walker (2018), Principles and Techniques of Biochemistry and Molecular Biology, 8th edition, Cambridge University Press, London.

   M.T. Madigan, J.M. Martinko, K.S. Bender, D.H. Buckley, D.A. Stahl (2015), Brock Biology of Microorganisms, 14th edition, Pearson Education, Inc., San Francisco.

3. L. Stryer (2018), *Biochemistry*, 8th edition, W.H. Freeman and Company, New York.

Web Sources:

1. https://www.boyertownasd.org/cms/lib/PA01916192/Centricity/Domain/99/New_Academic_Biology_Book/4_4_What_Is_Bioenergetics.pdf?utm_source=chatgpt.com
2. https://ocw.mit.edu/courses/7-05-general-biochemistry-spring-2020/81639cc0250aea63a83b63bb0f7b9d8e_xxydY73V9bQ.pdf?utm_source=chatgpt.com

24RMIM41 **RESEARCH PROJECT 1**

L	T	P	O	C
0	0	12	10	12

The students should do research on their own interest or research guide interest on any topic for 6 months in the university or any industries or laboratories in the Fourth Semester and the project report shall be submitted at the end of the semester.

In case the candidate undertakes the project work outside the Department, he/she shall bring the attendance certificate from the place of project work carried out.

After the research, he/she should submit the detailed reports about the research as a dissertation and should present the same during the examination conducted by the internal and external examiners.

Evaluation of the project will be done based on the work done, the quality of the project report, students's performance in the viva-voce and presentation.