

# VIVEKANANDHA

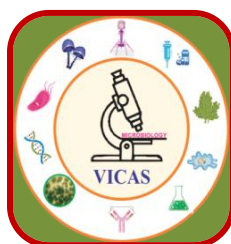
## COLLEGE OF ARTS AND SCIENCES FOR WOMEN

ELAYAMPALAYAM, TIRUCHENGODE (Tk.), NAMAKKAL (Dt.).

(An ISO 9001:2015 Certified institution, Affiliated to Periyar University, Approved by AICTE, Re-Accredited with 'A' Grade by NAAC, recognized under section 2(f) & 12(B) of UGC ACT 1956)



### PG AND RESEARCH DEPARTMENT OF MICROBIOLOGY



### M.Sc., MICROBIOLOGY

### PROGRAMME CODE: PMB

### SYLLABUS & REGULATIONS

FOR CANDIDATES ADMITTED FROM  
2024 - 2025 ONWARDS  
UNDER AUTONOMOUS & OBE PATTERN

VIVEKANANDHA EDUCATIONAL INSTITUTIONS

ANGAMMAL EDUCATIONAL TRUST

**M.Sc., MICROBIOLOGY**

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# **VIVEKANANDHA COLLEGE OF ARTS AND SCIENCES FOR WOMEN (AUTONOMOUS)**

## **VISION**

To evolve into a centre of excellence in higher education through creative and innovative practices to secure social equity for women.

## **MISSION**

1. To provide sufficient learning infrastructure to the students to pursue their studies.
2. To provide good opportunity for higher education and conducive environment to the students to acquire education.
3. To provide high quality academic programme, training activities and research facilities.
4. To facilitate industry-institute interface.

## **PG AND RESEARCH DEPARTMENT OF MICROBIOLOGY**

## **VISION**

Aspires to be a microbiologist committed to progress the quality of human lives by exploring environment, fighting with disease and to utilize microbes for healthy food.

## **MISSION**

- To educate the students to acquire the academic excellence with national and international recognition.
- To train the students to recognize, investigate and to resolve the myriad of microbiological problems affecting health and the environment through the programme designs
- To contribute to the cutting edge in Microbiology by pursuing high quality research and other scholarly activities.
- To motivate the students to become a women entrepreneur by applying their knowledge in the field of microbiology.
- To establish as an expert resource within the geographical areas regarding all issues related to medical and environmental microbiology.

## **3. PROGRAM EDUCATIONAL OBJECTIVES (PEO'S)**

- To provide in-depth knowledge about core areas of biosciences such as biotechnology, biochemistry and microbiology.
  - To make students competent in the field of biosciences and allied areas by providing them hands on
-

experience in basic tools and techniques.

- To instil the ability for research and entrepreneurship in the students along with strong ethics and communication skills.
- To inculcate, facilitate, motivate and promote knowledge and technical skills in core areas of biological sciences including advanced tools and techniques to the young aspirants.
- To equip and motivate the students to pursue higher education and research in reputed institutes at national and international level in the field of science.
- To develop trained human resource in the field of advanced translational research.
- To provide students with an understanding of the role of science in societal development.
- To develop graduates with a strong professional ethics and moral duties that will positively affect their profession, community, society and Nation at large.

#### **4.PROGRAMME OUTCOME:**

<b>POs</b>	<b>OUTCOME</b>
PO-1	<b>Problem Solving and Decision making Skill</b> Ability to draw conclusions from one's knowledge and use one's skills to address a variety of unfamiliar problems and to encourage the development of analytical and critical thinking skills for data-driven decision-making.
PO-2	<b>Employability and entrepreneurial skill</b> Inculcate contemporary business practices to enhance employability skills in the competitive environment and to equip with skills and competencies to become an entrepreneur.
PO-3	<b>Communication and Leadership Skill</b> Capacity to enhance interpersonal, management, and communication abilities.
PO-4	<b>Multi cultural competence with Contribution to society</b> Possess knowledge of the values and beliefs of multiple cultures and a global perspective; and capability to effectively engage in a multicultural society and interact respectfully with diverse groups.
PO-5	<b>Moral and Ethical Values</b> The capacity to live a life that upholds moral and ethical principles, to think critically about and present arguments for positions on moral issues, and to apply moral principles to all aspects of one's job.

#### **5.PROGRAMME SPECIFIC OUTCOME:**

PSO 1 This program provides comprehensive knowledge and practical training in the spread of microorganisms, disease causation, diagnosis and treatment of pathogens significant to public health.

PSO 2 Students will acquire and demonstrate competency in laboratory safety and in routine and specialized microbiological laboratory skills applicable to microbiological research or clinical methods, including accurately reporting

observations and analysis.

PSO 3 Students gain the knowledge of principles and practices in the main applications of microorganisms to the industrial production of foods, microbial metabolites, proteins and other useful products, including the use of genetically modified organisms.

## **6. CONDITIONS FOR ADMISSION**

### **6.1 ELIGIBILITY CONDITIONS FOR ADMISSION**

Candidate who has passed the B.Sc., degree in any Life Sciences such as Microbiology / Applied Microbiology/ Industrial Microbiology/ Botany/ Plant Sciences and Plant Biotechnology/ Zoology/ Animal Science/ Applied Animal Science and Animal Biotechnology/ Biochemistry/ Bioinformatics/ Biology/Home Science/ Food Science and Nutrition/ BHMS/ BSMS/ BAMS/ BUMS/ Chemistry with Botany or Zoology as Allied Subjects of this University or any other University accepted by the Syndicate as equivalent there to shall be eligible for admission to M.Sc., Degree Course in Microbiology.

### **6.2 ELIGIBILITY FOR THE AWARD OF DEGREE**

A candidate shall be eligible for the award of the degree only if she has undergone the prescribed course of study in a college affiliated to the University for a period of not less than two academic years, passed the examination of all the four semesters prescribed, earning 90 credits and fulfilled such conditions as have been prescribed therefore.

## **7. DURATION OF THE COURSE**

The duration of the course is for two academic years consisting of four semesters.

## **8. EXAMINATIONS**

There shall be four semester examinations: first semester examinations at the middle of the first academic year and the second semester examination at the end of the first academic year. Similarly, the third and fourth semester examinations shall be held at the middle and the end of the second academic year, respectively.

## **9. SCHEME OF EXAMINATIONS**

The scheme of examinations for different semesters shall be as follows:

<b>Theory External marks</b>	=	<b>75</b>
<b>Part A</b>	=	<b>10 Marks (01 x 10)</b>
<b>Part B</b>	=	<b>35 Marks (05 x 07)</b>
<b>Part C</b>	=	<b>30 Marks (03 x 10)</b>
<b>Internal marks</b>	=	<b>25</b>
<b>Total Marks</b>	=	<b>100</b>
<b>Time</b>	=	<b>3 Hrs.</b>

## **10. DURATION OF END SEMESTER EXAMINATION : 3 Hrs.**

### **The following procedure will be followed for Internal Marks**

#### **Theory - Internal Marks**

Theory best average of two tests	10 Marks
Attendance	5 Marks
Seminar	5 Marks
Assignment	5 Marks
<b>Total</b>	<b>25 Marks</b>

#### **Practical - Internal Marks**

Practical best average of two tests	25 Marks
Attendance	10 Marks
Observation Note	5 Marks
<b>Total</b>	<b>40 Marks</b>

#### **Project- Internal Marks**

Presentations [Two reviews 25+25]	50 Marks
Project Report (External marks)	150 Marks
<b>Total</b>	<b>200 Marks</b>

#### **Break-up Details for Attendance**

<b>Below 75%</b>	<b>No Marks</b>
<b>76 to 80%</b>	<b>01 Marks</b>
<b>81 to 85%</b>	<b>02 Marks</b>
<b>86 to 90%</b>	<b>03 Marks</b>
<b>91 to 95%</b>	<b>04 Marks</b>
<b>96 to 100%</b>	<b>05 Marks</b>

## **11. REQUIREMENTS FOR PROCEEDING TO SUBSEQUENT SEMESTERS**

- (i) Candidates shall register their names for the first semester examination after the admission in the PG courses.
- (ii) Candidates shall be permitted to proceed from the first semester up to the final semester irrespective of their failure in any of the semester examination subject to the condition that the candidates should register for all the arrear subjects of earlier semesters along with current (subject) semester subjects.
- (iii) Candidates shall be eligible to proceed to the subsequent semester, only if they earn sufficient attendance as prescribed therefore by the Syndicate from time to time. Provided in case of candidate earning less than

50% of attendance in any one of the semester due to any extraordinary circumstance such as medical grounds, such candidates who shall produce Medical Certificate issued by the Authorized Medical Attendant (AMA), duly certified by the Principal of the College, shall be permitted to proceed to the next semester and to complete the course of study. Such candidate shall have to repeat the missed semester by rejoining after completion of final semester of the course, after paying the fee for the break of study as prescribed by the college from time to time.

## **12. PASSING MINIMUM**

- a) The Passing Minimum for Internal. shall be Fifty Percentage)of the maximum marks prescribed for the paper.
- b) For External Examination, Passing Minimum shall be of 50% (Fifty Percentage) of the maximum marks prescribed for the paper.
- c) In the aggregate (External + Internal) the passing minimum shall be of 50% for each Paper/Practical/Project and Viva-voce.
- d) Grading shall be based on overall marks obtained (Internal + External)

## **13. CLASSIFICATION OF SUCCESSFUL CANDIDATES**

Candidates who secured not less than 60% of aggregate marks (Internal + External) in the whole examination shall be declared to have passed the examination in the first class. All other successful candidates shall be declared to have passed in second class. Candidates who obtain 75% of the marks in the aggregate (Internal + External) shall be deemed to have passed the examination in first class with distinction, provided they pass all the examinations (theory papers, practical, project and viva-voce) prescribed for the course in the first appearance.

## **14. GRADING SYSTEM**

The term grading system indicates a 7 point scale of evaluation of the performances of students in terms of marks obtained in the Internal and External examination, grade points and letter grade.

### **SEVEN POINT SCALE (As per UGC notification, 1998)**

<b>GRADE</b>	<b>GRADE POINT</b>	<b>PERCENTAGE EQUIVALENT</b>
<b>'O'= Outstanding</b>	<b>5.50 – 6.00</b>	<b>75 – 100</b>
<b>'A'= Very Good</b>	<b>4.50 – 5.49</b>	<b>65 – 74</b>
<b>'B' = Good</b>	<b>3.50 – 4.49</b>	<b>55 – 64</b>
<b>'C'= Average</b>	<b>3.00 – 3.49</b>	<b>50 – 54</b>
<b>'D'= Below Average</b>	<b>1.50 – 2.99</b>	<b>35 – 49</b>
<b>'E'= Poor</b>	<b>0.50 – 1.49</b>	<b>25 – 34</b>
<b>'F'= Fail</b>	<b>0.00 – 0.49</b>	<b>00 – 24</b>

## **15. RANKING**

Candidates who pass all the examinations prescribed for the course in the first appearance itself alone are eligible for Ranking / Distinction. Provided in the case of candidates who pass all the examinations prescribed for the course with a break in the first appearance will not be eligible for ranking.

## **16. PATTERN OF QUESTION PAPER**

PART A (Objective): Answer All the Questions **01 x 10 = 10 Marks**

PART B (200 words): Answer All the Questions (Internal choice) **05 x 07 = 35 Marks**

PART C (500 words): Answer any Three Questions out of 5 **03x 10 = 30 Marks**

## **17. PROCEDURE IN THE EVENT OF FAILURE**

If a candidate fails in particular subjects, she may reappear for the examination in the concerned subject in subsequent semester and shall pass the examination.

## **18. COMMENCEMENT OF THESE REGULATIONS**

These regulations shall take effect from the academic year 2023-2024 (i.e.,) for the students who are to be admitted to the first year of the course during the academic year 2023-24 and thereafter.

## **19. TRANSITORY PROVISION**

Candidates who were admitted to the PG course of Microbiology before 2024 – 2025 shall be permitted to appear for the examinations under those regulations for a period of two years i.e., upto and inclusive of the examination of Apr/May 2026. Thereafter, they will be permitted to appear for the examination only under the regulations then in force.

**SCHEME OF CURRICULUM– M.Sc., MICROBIOLOGY**  
(For the candidates admitted during the academic year 2024-2025 onwards)

Sem	Subject code	Course	Subject title	Hrs/week	Credits	Int.marks	Ext.marks	Tot. marks
<b>I</b>	23P1MBC01	Core– I	General Microbiology and Microbial Diversity	6	4	25	75	100
	23P1MBC02	Core –II	Immunology, Immunotechnology and Immunomics	6	4	25	75	100
	23P1MBCP01	Core Practical-I	General Microbiology and Immunotechnology Practical – I	6	4	40	60	100
	23P1MBDE01	Elective –I	Forensic Science	4	3	25	75	100
	23P1MBDE02		Microalgal Technology					
	23P1MBDE03	Elective – II	Herbal Technology and Cosmetic Microbiology	4	3	25	75	100
	23P1MBDE04		Developmental Biology					
	23P1MBPC01	Professional Competency course	Entrepreneurship in Biobusiness	2	2	25	75	100
	23P1MBAC01	AECC-I	Human Anatomy and Physiology	2	2	25	75	100
<b>Total</b>				<b>30</b>	<b>22</b>	<b>190</b>	<b>510</b>	<b>700</b>
<b>II</b>	23P2MBC04	Core–III	Medical Bacteriology & Mycology	6	4	25	75	100
	23P2MBC05	Core– IV	Microbial Genetics and Recombinant DNA technology	6	4	25	75	100
	23P2MBCP02	Core Practical-II	Bacteriology, Mycology Microbial Genetics and Recombinant DNA Technology Practical – II	6	4	40	60	100
	23P2MBDE05	Elective-III	Clinical Diagnostic Microbiology	4	4	25	75	100
	23P2MBDE06		Bioremediation					
	23P2MBDE07	Elective-IV	Nanobiotechnology	4	4	25	75	100
	23P2MBDE08		Poultry Microbiology					
	24P2MBDE09		Marine Microbiology					
	23P2MBS01	SEC-I	Vermitechnology	2	2	25	75	100
23P2MBAC02	AECC – II	Epidemiology	2	2	25	75	100	
<b>Total</b>				<b>30</b>	<b>24</b>	<b>190</b>	<b>510</b>	<b>700</b>
<b>III</b>	23P3MBC05	Core–V	Medical Virology & Parasitology	5	5	25	75	100
	23P3MBC06	Core –VI	Soil and Environmental Microbiology	5	5	25	75	100
	23P3MBC07	Core- VII	Food and Fermentation Technology	5	5	25	75	100
	23P3MBCP03	Core practical –III	Virology, Parasitology, Soil and Food Microbiology Practical-III	5	4	40	60	100
	23P3MBDE10	Elective-V	Metagenomics	4	4	25	75	100
	23P3MBDE11		Bioethics, Biosafety and IPR					
	23P3MBDE12		Water treatment and Water Pollution Management					
	23P3MBDE13	Elective – VI	Microbial Genomics	4	4	25	75	100
	23P3MBDE14		Organic Farming for Sustainable Agriculture					
23P3MBDE15	Microbial quality control and testing							
23P3INT01	Internship	During summer holidays after II Sem	-	2	-	-	-	
23P3HR01		Human Rights	2	1	25	75	100	
<b>Total</b>				<b>30</b>	<b>30</b>	<b>290</b>	<b>570</b>	<b>700</b>
<b>IV</b>	23P4MBC08	Core- VIII	Research Methodology and Biostatistics	6	5	25	75	100
	23P4MBED01		Medical Laboratory Technology	2	2	40	60	100
	23P4MBPR01	Project	Project with Vivavoce	24	8	50	150	200
<b>Total</b>				<b>30</b>	<b>15</b>	<b>115</b>	<b>285</b>	<b>400</b>
<b>Over all Total</b>				<b>120</b>	<b>91</b>	<b>685</b>	<b>1845</b>	<b>2500</b>



# SEMESTER I

**SEMESTER-I**  
**23P1MBC01**  
**Credits-4**

**CORE-I**  
**Total Number of Hours:60**  
**6 Hours/Week**

## **GENERAL MICROBIOLOGY AND MICROBIAL DIVERSITY**

### **Course Objectives:**

- Acquire knowledge on the principles of different types of microscopes and their applications.
- Compare and contrast the structure of bacteria and fungi. Illustrate nutritional requirements and growth in bacteria.
- Exemplify, isolate and cultivate microalgae from diverse environmental sources.
- Explain various pure culture techniques and discuss sterilization methods.
- Discuss the importance and conservation of microbial diversity.

### **Course Outcome:**

<b>CO1</b>	Examine various microbes employing the microscopic techniques learnt. Measure and Compare the size of microbes.
<b>CO2</b>	Differentiate and appreciate the anatomy of various microbes. Plan the growth of Microbes for different environmental conditions.
<b>CO3</b>	Identify and cultivate the algae understanding their habitat. Analyze the morphology, Classify and propagate depending on its economic importance.
<b>CO4</b>	Create aseptic conditions by following good laboratory practices.
<b>CO5</b>	Categorize and cultivate a variety of extremophiles following standard protocols for Industrial applications.

### **UNIT-I**

**No. of Hours:12**

**History and Scope of Microbiology.** Microscopy–Principles and applications. Types of Microscopes – Bright field, Dark-field, Phase-contrast, Fluorescence microscope, Transmission electron microscope (TEM) and Scanning electron microscope (SEM). Sample preparation for SEM &TEM. Atomic force, Confocal microscope. Micrometry– Stage, Ocular and its applications.

### **UNIT-II**

**No. of Hours:12**

**Bacterial Structure, properties and biosynthesis of cellular components**–Cell wall. Actinomycetes and Fungi - Distribution, morphology, classification, reproduction and economic importance. Sporulation. Growth and nutrition-Nutritional requirements, Growth curve, Kinetics of growth, Batch culture, Synchronous growth, Measurement of growth and factors affecting growth.

**UNIT-III****No. of Hours:12**

**Algae** - Distribution, morphology, classification, reproduction and economic importance. Isolation of algae from soil and water. Media and methods used for culturing algae, Strain selection and large-scale cultivation. Lifecycle-*Chlamydomonas*, *Volvox*, *Spirogyra*(Green algae), *Nostoc*(Cyanobacteria) *Ectocarpus*, *Sargassum*(Brownalgae), *Polysiphonia*, *Batrachospermum* (Redalgae).

**UNIT-IV****No. of Hours: 12**

**Microbial techniques** - Safety guidelines in Microbiology Laboratories. Sterilization, Disinfection and its validation. Staining methods – Simple, Differential and Special staining. Automated Microbial identification systems-Pure cultures techniques–Cultivation of Anaerobic organisms. Maintenance and preservation of pure cultures. Culture collection centres – National and International.

**UNIT-V****No. of Hours:12**

**Biodiversity** - Introduction to microbial biodiversity – Thermophiles -Classification, Thermophilic Archaeobacteria and its applications. Methanogens- Classification, Habitats, applications. Alkaliphiles and Acidophiles- Classification, discovery basin, its cell wall and membrane. Barophiles - Classification and its applications. Halophiles - Classification, discovery basin, cell walls and membranes – purple membrane, compatible solutes, Osmo adaptation / halotolerance –Applications of halophiles. Conservation of Biodiversity.

**Text Books**

1. Kanunga R. (2017). Ananthanarayanan and Panicker's Textbook of Microbiology. (10<sup>th</sup>Edition). Universities Press (India)Pvt. Ltd.
2. Chan E.C.S., Pelczar M. J. Jr.and Krieg N.R. (2010).Microbiology. (5<sup>th</sup>Edition). Mc. Graw Hill. Inc, New York.
3. Prescott L.M., Harley J.P. and KleinD.A.(2004).Microbiology.(6<sup>th</sup>Edition).McGraw-Hillcompany,NewYork.
4. White D. Drummond J. and Fuqua C.(2011).The Physiology and Biochemistry of Prokaryotes, Oxford University Press, Oxford, New York.
5. Dubey R.C. and Maheshwari D. K.(2009).Textbook of Microbiology. S. Chand, Limited.

## Reference Books

1. Tortora G.J., Funke B.R. and Case C.L.(2015).Microbiology: An Introduction (12<sup>th</sup> Edition). Pearson, London, United Kingdom
2. Webster J.and Weber R.W.S.(2007).Introduction to Fungi.(3<sup>rd</sup>Edition).Cambridge University Press, Cambridge.
3. Schaechter M. and Leaderberg J. (2004). The Desk encyclopedia of Microbiology. Elsevier Academic Press, California.
4. Ingraham, J. L. and Ingraham, C.A.(2000) Introduction to Microbiology. (2<sup>nd</sup>Edition). Books / Cole Thomson Learning, UK.
5. Madigan M.T., Bender K.S., Buckley D. H. Sattley W.M. and Stahl (2018) Brock Biology of Microorganisms.(15<sup>th</sup> Edition).Pearson.

## Web Sources:

1. <http://scienetlinks.com/tools/microbeworldhttp://www.microbiologyonline.org.uk/links.html>
2. <https://www.microbes.info/>
3. <https://www.asmscience.org/VisualLibrary>
4. <https://open.umn.edu/opentextbooks/BookDetail.aspx?bookId=404>
5. [https://www.grsmu.by/files/file/university/cafedry//files/essential\\_microbiology.pdf](https://www.grsmu.by/files/file/university/cafedry//files/essential_microbiology.pdf)

**SEMESTER- I**  
**23P1MBC02**  
**Credits- 4**

**CORE-II**  
**Total Number of Hours:60**  
**6 Hours/Week**

## **IMMUNOLOGY, IMMUNOTECHNOLOGY AND IMMUNOMICS**

### **Course Objectives**

- Discuss immunity, organs and cells involved in immunity. Compare the types of antigens and their properties.
- Describe immunoglobulin and its types. Categorize MHC and understand its significance.
- Elucidate the mechanisms of different hypersensitivity, Autoimmunity, Tumor Immunology, Transplantation immunology.
- Acquire knowledge about Immuno haematology and Immunodiagnostic methods
- Explain about the Immuno regulatory mechanism and Immunomics

### **Course Outcome**

<b>CO1</b>	Categorize the immune response to a variety of antigens. Identify different immune Cells and organs involved in immunity.
<b>CO2</b>	Classify the immunoglobulins and Justify the significance of MHC molecules in immune response and antibody production.
<b>CO3</b>	Differentiate the hypersensitivity reactions, Tumor immunology, Transplantation Immunology, Autoimmunity and Immuno deficiency disorders.
<b>CO4</b>	Perform various immuno hametological and immune diagnostic techniques.
<b>CO5</b>	Appreciate the significance of immune regulatory mechanisms, Vaccines and immunomics.

### **UNIT-I**

**No. of Hours:12**

**Introduction to biology of the immune system** – Cells and organs of Immune System. T and B lymphocytes – Origin, development, differentiation, lymphocyte subpopulation in humans. Innate immunity- Acquired immunity – Active and Passive immunity. Antigens - features associated with antigenicity and immunogenicity. Basis of antigen specificity. MHC genes and products, Structure of MHC molecules–Antigens and HLA typing. Antigen processing and presentation to T-lymphocytes.

## **UNIT-II**

**No. of Hours:12**

**Immunoglobulins.** Theories of antibody production. Class switching and generation of antibody diversity. Monoclonal and polyclonal antibodies. Complement system–mode of activation-Classical, Alternate and Lectin pathways, biological functions. Antigen recognition– TCR, Diversity of TCR, T cell surface allo-antigens, lymphocyte activation, clonal proliferation and differentiation. Physiology of acquired immune response – various phases of HI, CMI – Cell mediated cytotoxicity, DTH response.

## **UNIT-III**

**No. of Hours: 12**

**Hypersensitivity** – Types and mechanisms, Autoimmunity, Tumor Immunity and Transplantation immunology. Immunodeficiency –Primary immune deficiency and Secondary immune deficiencies.

## **UNIT-IV**

**No. of Hours: 12**

Genetics of Immunohematology – Genetic basis and significance of ABO and other minor blood groups in humans, Bombay blood group, Secretors and Non-secretors, Rh System and genetic basis of D- antigens. Diagnostic Immunology - Precipitation reaction, Immuno-diffusion methods - SRID, ODD. Immuno electrophoresis- Rocket and Counter current electrophoresis. Agglutination-Hemagglutination- Hemagglutination inhibition. Labeled Assay- Immuno fluorescence assay, Radioimmunoassay, FISH, ELISA. Flowcytometry.

## **UNIT-V**

**No. of Hours:12**

Immune regulation mechanisms – immuno-induction, immuno- suppression, immuno-tolerance, immuno- potentiation, Immunomodulation. Role of cytokines, lymphokines and chemokines. Introduction to Vaccines and Adjuvants-Types of vaccines. Development of vaccines and antibodies in plants. Immunomics - Introduction and Applications. Antigen engineering for better immunogenicity and use for vaccine development-multi epitope vaccines. Reverse vaccinology.

## **Text Books**

1. Coico R., Sunshine G. and Benjamini E. (2003). Immunology – A Short Course. (5<sup>th</sup> Edition). Wiley-Blackwell, New York.
2. Owen J. A., Punt J., Stranford S. A. and Kuby J. (2013). Immunology, (7<sup>th</sup> Edition). W. H. Freeman and Company, New York.
3. Abbas A.K., Lichtman A.H. and Pillai S. (2021). Cellular and Molecular Immunology. (10<sup>th</sup> Edition). Elsevier.
4. Kindt T.J., Goldsby R.A., Osborne B.A. and Janis Kuby (2007). Kuby Immunology. W.H.

Freeman and Company, NewYork.

5. Tizard IR (1995). Immunology: An Introduction. 4<sup>th</sup> Edition. Saunders College Publishers, USA.

### **Reference Books**

1. Travers J. (1997). Immunobiology - The Immune System in Health and Disease. (3<sup>rd</sup>Edition).Current Biology Ltd. NewYork.
2. Delves P.J., MartinS., BurtonD. R. and RoittI.M. (2006).Roitt's Essential Immunology. (11<sup>th</sup>Edition).Wiley-Blackwell.
3. Hay F.C. and Westwood O.M.R.( 2002).Practical Immunology(4<sup>th</sup>Edition).Wiley-Blackwell.

### **Web Sources:**

- 1.<https://med.stanford.edu/immunol/phd-program/ebook.html>
2. <https://ocw.mit.edu/courses/hst-176-cellular-and-molecular-immunology-fall-2005/pages/lecture-notes/>
- 3.<https://www.ncbi.nlm.nih.gov/books/NBK279395/>

**SEMESTER-I**  
**23P1MBCP01**  
**Credits-4**

**CORE PRACTICAL-I**  
**Total Number of Hours: 60**  
**6 Hours/Week**

## **PRACTICAL-I**

### **Course Objectives**

- Gain knowledge on the fundamentals, microscopy, sterilization methods and staining methods.
- Prepare media for bacterial growth, enzymatic activities and biochemical tests.
- Discuss plating and growth measurement techniques.
- Acquire adequate skills to perform blood grouping and serological tests.
- Provide fundamental skills in preparation, separation and purification of immunoglobulin and ELISA.

### **Course Outcome**

<b>CO1</b>	Apply basic microbiological techniques, microscopic techniques and staining methods In the identification and differentiation of microbes.
<b>CO2</b>	Apply the knowledge on preparation of different media for enzymatic activities and Biochemical tests.
<b>CO3</b>	Perform pure culture methods-aerobic and an aerobic, enumeration of bacteria and Growth curve
<b>CO4</b>	Perform immune hematological and Immunodiagnostic techniques.
<b>CO5</b>	Assess the level of lymphocytes in a blood sample and purify immunoglobulin Employing appropriate techniques and ELISA.

1. Washing and cleaning of glass wares
2. Sterilization methods: moist heat, dry heat, and filtration and quality control check for each method.
3. Microscopic Techniques: Light microscopy: Hay infusion broth. Wet mount to show different types of microbes, Hanging drop.
4. Staining techniques – Simple staining, Gram’s staining, Acid fast staining, Metachromatic granule staining, Spore staining and Capsule staining.
5. Media Preparation: Preparation of liquid, solid and semisolid media. Agar deeps, slants, plates. Preparation of basal, enriched, selective and enrichment media. Preparation of Biochemical test



media and media to demonstrate enzymatic activities.

6. Microbial Physiology: Purification and maintenance of microbes. Streak plate, pour plate, and slide culture technique. Aseptic transfer.
7. Direct counts – Total cell count, Turbidometry. Viable count -pour plate, spread plate.
8. Bacterial growth curve.
9. Effect of physical and chemical factors on growth.
10. Anaerobic culture methods.
11. Hematological reactions - Blood Grouping – forward and reverse, Rh Typing.
12. Identification of various immune cells by morphology–Leishman staining ,Giemsa staining. Agglutination Reactions-Latex Agglutination reactions- RF, ASO, CRP.
13. Precipitation reactions in gels– Ouchterlony double immunodiffusion (ODD) and Mancini's single radial immunodiffusion (SRID).
14. Immuno-electrophoresis and staining of precipitin lines- Rocket immunoelectrophoresis and countercurrent immuno electrophoresis.
15. Preparation of lymphocytes from peripheral blood by density gradient centrifugation. Purification of immunoglobulin–Ammonium Sulphate Precipitation.
16. Separation of IgG by chromatography using DEAE cellulose or Sephadex.
17. Detection of HBsAg by ELISA. Western Blotting–Demonstration.

### **Text Books**

1. Dubey R.C. and Maheshwari D.K. (2010). Practical Microbiology. S. Chand.
2. Cappuccino, J. and Sherman, N. (2002). Microbiology: A Laboratory Manual, (6<sup>th</sup> Edition). Pearson Education, Publication, New Delhi.
3. Cullimore D.R. (2010). Practical Atlas for Bacterial Identification. (2<sup>nd</sup> Edition).- Taylor & Francis.
4. Rich R. R., Fleisher T.A., Shearer W. T., Schroeder H, Frew A. J. and Wey and C. M. (2018). Clinical Immunology: Principles and Practice. (5<sup>th</sup> Edition). Elsevier.
5. Aneja, K.R., 2003, "Experiments in Microbiology and Plant Pathology", New Age Publications, New Delhi.
6. Arora, Band D.R. Arora, 2013, Practical Microbiology, CBS Publishers & distributors Pvt. Ltd, New Delhi.

## Reference Books

1. Collee J. G., Fraser A.G. Marmion B.P. and Simmons A. (1996).Mackie & McCartney Practical Medical Microbiology. (14<sup>th</sup>Edition). Elsevier, NewDelhi.
2. GuptaP.S. (2003).Clinical Immunology. Oxford University Press.

## Web Sources:

1. <http://textbookofbacteriology.net/>
2. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC149666/>
3. <https://ocw.mit.edu/courses/hst-176-cellular-and-molecular-immunology-fall-2005/pages/lecture-notes/>
4. [\[PDF\]LehningerPrinciplesofBiochemistry\(8<sup>th</sup>Edition\)ByDavidL.NelsonandMichaelM.CoxBookFree Download-StudyMaterialz.in](#)
5. <https://microbenotes.com/gene-cloning-requirements-principle-steps-applications/>

**SEMESTER – I**  
**23P1MBDE01**  
**Credits– 3**

**ELECTIVE–I**  
**Total Number of Hours:45**  
**4 Hours/Week**

## **FORENSIC SCIENCE**

### **Course Objectives:**

- Understand the Scope, need and learn the tools and techniques in forensic science.
- Comprehend organizational setup of a forensic science laboratory.
- To impart the knowledge on forensic serology
- To know the methods of extraction and identification of DNA
- To get the knowledge on forensic toxicology

### **Course Outcome:**

<b>CO1</b>	Identify the scope and need of forensic science in the present scenario.
<b>CO2</b>	Plan for the organizational setup and functioning of forensic science laboratories.
<b>CO3</b>	Analyze the biological samples found at the crime scene.
<b>CO4</b>	Perform extraction and identification of DNA obtained from body fluids.
<b>CO5</b>	Discuss the concept of forensic toxicology.

### **UNIT-I**

**No. of Hours: 09**

**Forensic Science** - Definition, history and development of forensic science. Scope and need of forensic science in present scenario. Branches of forensic science. Tools and techniques of forensic science. Duties of a forensic scientist.

### **UNIT-II**

**No. of Hours: 09**

**Forensic science laboratories** - Organizational setup of a forensic science laboratory. Central and State level laboratories in India. Mobile forensic science laboratory and its functions. Forensic microbiology- Types and identification of microbial organisms of forensic significance.

### **UNIT-III**

**No. of Hours: 09**

**Forensic serology** - Definition, identification and examination of body fluids - Blood, semen, saliva, sweat and urine. Forensic examination and identification of hair and fibre.

**UNIT-IV****No. of Hours: 09**

**DNA profiling** - Introduction, history of DNA typing. Extraction of DNA from blood samples -Organic and Inorganic extraction methods. DNA fingerprinting - RFLP, PCR, STR. DNA testing in disputed paternity.

**UNIT-V****No. of Hours: 09**

**Forensic toxicology-** Introduction and concept of forensic toxicology. Medico-legal postmortem and their examination. Poisons-Types of poisons and their mode of action.

**Textbooks**

1. Nanda B. B. and Tewari R. K. (2001) Forensic Science in India: A Vision for the Twenty First Century. Select Publishers, New Delhi. ISBN-10:8190113526/ ISBN-13:9788190113526.
2. James S.H. and Nordby, J.J.(2015)Forensic Science: An Introduction to Scientific and Investigative Techniques. (5<sup>th</sup> Edition). CRC Press. ISBN-10:9781439853832 / ISBN-13:978-1439853832.
3. Li R. (2015) Forensic Biology. (2<sup>nd</sup> Edition). CRC Press, New York. ISBN-13:978-1-4398-8972-5.
4. Sharma B.R (2020) Forensic science in criminal investigation and trials. (6<sup>th</sup>Edition) Universal Press.
5. Richard Saferstein (2017). Criminalistics- An introduction to Forensic Science. (12<sup>th</sup>Edition). Pearson Press.

**Reference books**

1. Nordby J.J. (2000) .Dead Reckoning. The Art of Forensic Detection-CRC Press, New York. ISBN: 0-8493- 8122- 3.
2. Saferstein R. and Hall A. B. (2020).Forensic Science Handbook, Vol. I , (3<sup>rd</sup>Edition).CRC Press, New York. ISBN-10:1498720196.
3. Lincoln, P.J. and Thomson, J. (1998). (2<sup>nd</sup> Edition). Forensic DNA Profiling Protocols. Vol.98.Humana Press.ISBN:978-0-89603-443-3.
4. Val McDermid(2014). Forensics.(2<sup>nd</sup>Edition). ISBN9780802125156.
5. Vincent J. Di Maio., Dominick Di Maio. (2001). Forensic Pathology (2<sup>nd</sup>Edition).CRC Press.

## **Web Sources:**

1. <http://clsjournal.ascls.org/content/25/2/114>
2. <https://www.ncbi.nlm.nih.gov/books/NBK234877/>
3. <https://www.elsevier.com/books/microbial-forensics/budowle/978-0-12-382006-8>
4. [https://www.researchgate.net/publication/289542469\\_Methods\\_in\\_microbial\\_forensics](https://www.researchgate.net/publication/289542469_Methods_in_microbial_forensics)
5. <https://cisac.fsi.stanford.edu/events/microbialforensics>

**SEMESTER – I**  
**23P1MBDE02**  
**Credits– 3**

**ELECTIVE–I**  
**Total Number of Hours:45**  
**4 Hours/Week**

## **MICROALGAL TECHNOLOGY**

### **Course Objectives:**

- Characterize the different groups of algae.
- Describe the cultivation and harvesting of algae
- Identify the commercial applications of various algal products
- Apply microalgae for environmental applications
- Employ microalgae as alternate fuels

### **Course Outcome:**

<b>CO1</b>	Acquire knowledge in the field of Microalgal technology and their characteristics.
<b>CO2</b>	Identify the methods of algal cultivation and harvesting.
<b>CO3</b>	Recognize and recommend the use of microalgae as food, feed and fodder
<b>CO4</b>	Promote microalgae in phyco-remediation
<b>CO5</b>	Compare and critically evaluate recent applied research in these microalgal applications.

### **UNIT-I**

**No. of Hours: 09**

**Introduction to Algae** - General characteristics. Classification of algae according to Fritsch. Salient features of different groups of algae. Distribution - Freshwater, brackish water and marine algae. Identification methods. An overview of applied Phycology. Economically important microalgae.

### **UNIT-II**

**No. of Hours: 09**

**Cultivation of freshwater and marine microalgae** - Growth media. Isolation and enumeration of microalgae. Laboratory cultivation and maintenance. Outdoor cultivation-Photo bioreactors-construction, types and operation; raceway ponds - Heterotrophic and mixotrophic cultivation-Harvesting of microalgae biomass.

### UNIT-III

No. of Hours: 09

**Microalgae in food and nutraceutical applications** - Algal single cell proteins. Cultivation of Spirulina and Dunaliella. Microalgae as aquatic, poultry and cattle feed. Microalgal biofertilizers. Value-added products from microalgae. Pigments - Production of microalgal carotenoids and their uses. Phycobili proteins -production and commercial applications. Polyunsaturated fatty acids as active nutraceuticals. Microalgal secondary metabolites –Pharmaceutical and cosmetic applications.

### UNIT-IV

No. of Hours: 09

**Microalgae in environmental applications. Phyco-remediation-** Domestic and industrial wastewater treatment. High-rate algal ponds and surface- immobilized systems - Treatment of gaseous wastes by microalgae. Sequestration of carbon dioxide. Scavenging of heavy metals by microalgae. Negative effects of algae. Algal blooms, algicides for algal control.

### UNIT-V

No. of Hours: 09

**Microalgae as feedstock for production of biofuels-** Carbon-neutral fuels. Lipid- rich algal strains - *Botryococcusbraunii*. Drop-in fuels from algae - hydrocarbons and biodiesel, bioethanol, biomethane, biohydrogen and syngas from microalgae biomass. Bio crude synthesis from microalgae. Integrated bio-refinery concept. Life cycle analysis of algae biofuels.

### Text Books

1. Lee R.E.(2008).Phycology. Cambridge University Press.
2. Sharma O.P.(2011).Algae. Tata McGraw-Hill Education.
3. ShekhA.,Schenk P.,Sarada R.(2021). Microalgal Biotechnology. Recent Advances, Market Potential and Sustainability. Royal Society of Chemistry
4. Lele.S.S.,Jyothi Kishen Kumar(2008).Algal bioprocess technology. New Age International P(Lt)
5. Das.,Mihirkumar. Algal Biotechnology. Daya Publishing House, NewDelhi.

### Reference Books

1. Andersen R.A.(2005).Algal culturing techniques. Academic Press, Elsevier.
2. BuxF. (2013). Biotechnological Applications of Microalgae: Biodiesel and Value-added Products. CRC Press.
3. Singh B.,Bauddh K.,Bux, F.(2015).Algae and Environmental Sustainability. Springer
4. Das D. (2015).An algal biorefinery: An integrated approach. Springer.
5. Bux F. And Chisti Y.(2016). Algae Biotechnology: Products and Processes. Springer.

## Web Sources

1. <https://www.classcentral.com/course/algae-10442>
2. [https://onlinecourses.nptel.ac.in/noc19\\_bt16/preview](https://onlinecourses.nptel.ac.in/noc19_bt16/preview)
3. <https://freevideolectures.com/course/4678/nptel-industrial-biotechnology/46>
4. <https://nptel.ac.in/courses/103103207>
5. <https://www.sciencedirect.com/topics/earth-and-planetary-sciences/microalgae>



**SEMESTER – I**  
**23P1MBDE03**  
**Credits– 3**

**ELECTIVE– II**  
**Total Number of Hours: 45**  
**4Hours/Week**

## **HERBAL TECHNOLOGY AND COSMETIC MICROBIOLOGY**

### **Course Objectives:**

- Impart knowledge of Indian Medicinal Plants and their applications in microbiology.
- Promote the technical skills involved in preparation of different types of plant extracts
- Explain methods to analyze the antimicrobial activity of medicinal plants.
- Acquire knowledge on cosmetic microbiology and role of microorganisms in cosmetics
- Gain insight into pharmacopeial microbial assays and biosafety.

### **Course Outcome:**

<b>CO1</b>	Identify the applications of Indian medicinal plants in treating diseases.
<b>CO2</b>	Identify and authenticate herbal plants.
<b>CO3</b>	Evaluate the antimicrobial activity of medicinal plants.
<b>CO4</b>	Describe the role of microorganisms and their metabolites in the preparation of cosmetics.
<b>CO5</b>	Validate procedures and biosafety measures in the mass production of cosmetics.

### **UNIT-I**

**No. of Hours: 09**

**Herbs, Herbal medicine** - Indian medicinal plants: Scope and Applications of Indian medicinal plants in treating bacterial, fungal and viral diseases. Basic principles involved in Ayurvedha, Sidha, Unani and Homeopathy.

### **UNIT-II**

**No. of Hours: 09**

**Collection and authentication of selected Indian medicinal plants:** *Emblica officinalis*, *Withania somnifera*, *Phyllanthus amarus*, *Tinospora cordifolia*, *Andrographis paniculata*, *Piperlongum*, *Ocimum sanctum*, *Azadirachta indica*, *Terminalia chebula*, *Allium sativum* .Preparation of extracts-Hot and cold methods. Preparation of stock solutions.

### **UNIT-III**

**No. of Hours: 09**

**Antimicrobial activity of selected Indian medicinal Plants:** - In vitro determination of antibacterial and fungal activity of selected whole medicinal plants/parts–well-diffusion methods. MIC - Macro and micro dilution techniques. Antiviral activity- cell lines- cytotoxicity, cytopathic and non-cytopathic effect.

## UNIT-IV

No. of Hours: 09

**History of Cosmetic Microbiology**–Need for cosmetic microbiology, Scope of cosmetic microbiology, - Role of microbes in cosmetic preparation. Preservation of cosmetics. Antimicrobial properties of natural cosmetic products – Garlic, neem, turmeric, aloe vera and tulsi. Sanitary practices in cosmetic manufacturing-HACCP protocols in cosmetic microbiology.

## UNIT-V

No. of Hours: 09

**Cosmetic microbiology test methods** - Antimicrobial preservative efficacy, microbial content testing and biological toxicological testing. Validation methods-bio burden and Pharmacopeial microbial assays. Preservatives of cosmetics - Global regulatory and toxicological aspect of cosmetic preservatives.

## Text Books

1. Ayurvedic Formulary of India. (2011).Part1,2&3.Pharmacopoeia Commission for Indian Medicine and Homeopathy.ISBN-10:8190648977.
2. Panda H. (2004). Handbook on herbal medicines. Asia Pacific Business Press Inc. ISBN: 8178330911.
3. Mehra P.S. (2019).A Text book of Pharmaceutical Microbiology. Dream tech Press.ISBN13: 9789389307344.
4. GeisP.A. (2020).Cosmetic microbiology: A Practical Approach. (3<sup>rd</sup>Edition). CRC Press. ISBN:9780429113697.
5. Brannan D.K. (1997). Cosmetic microbiology: A Practical Handbook. CRC Press. ISBN-10:0849337135.

## Reference Books

1. Indian Herbal Pharmacopoeia (2002).Vol.I& II Indian Drug Manufacturers Association, Mumbai.
2. British Herbal Pharmacopoeia. (1990).Vol.I. British Herbal Medicine Association. ISBN: 0903032090.
3. Verpoorte R. and Mukherjee, P.K.(2010). GMP for Botanicals: Regulatory and Quality issues on Phytomedicines. In GMP for botanicals: regulatory and quality issues on phyto medicines. (2<sup>nd</sup>edition). Saujanya Books, Delhi.ISBN-10:81-900788-5-2/8190078852.ISBN-13:978-81-900788-5-6/9788190078856.
5. Turner R.(2013). Screening methods in Pharmacology. Elsevier. ISBN: 9781483264233.
6. Cupp M.J. (2010). Toxicology and Clinical Pharmacology of Herbal Products (pp.85-93) M. J.Cupp. Humana Press. Totowa, NJ, USA.ISBN-10:1617371904

**Web sources:**

1. [https://www.academia.edu/50236711/Modern\\_Extraction\\_Methods\\_for\\_Preparation\\_of\\_Bioactive\\_Plant\\_Extracts](https://www.academia.edu/50236711/Modern_Extraction_Methods_for_Preparation_of_Bioactive_Plant_Extracts)
2. [https://www.nhp.gov.in/introduction-and-importance-of-medicinal-plants-and-herbs\\_mtl](https://www.nhp.gov.in/introduction-and-importance-of-medicinal-plants-and-herbs_mtl)
3. <https://pubmed.ncbi.nlm.nih.gov/17004305/>
4. <https://www.fda.gov/cosmetics/potential-contaminants-cosmetics/microbiological-safety-and-cosmetics>
5. <https://pubmed.ncbi.nlm.nih.gov/15156038/>

**SEMESTER – I**  
**23P1MBDE04**  
**Credits– 3**

**ELECTIVE–II**  
**Total Number of Hours:45**  
**4 Hours/Week**

## **DEVELOPMENTAL BIOLOGY**

### **Course Objectives:**

- The learner will acquire knowledge about developmental biology.
- The learner will learn the basic principles and development of organs.
- The learner will develop an understanding about morphogenesis and organogenesis.
- The learner will understand of the processes of early embryonic development and germination.
- The learner will learn the gene concept and their activation in development.

### **Course Outcome:**

<b>CO1</b>	Understand the origin of developmental biology
<b>CO2</b>	Acquire knowledge on the Morphogenesis and Organogenesis in animals
<b>CO3</b>	Acquire knowledge on the Morphogenesis and Organogenesis in plants
<b>CO4</b>	Gain in-depth detail about gametogenesis and fertilization
<b>CO5</b>	Analyze the role of genes in development.

### **UNIT-I**

**No. of Hours: 09**

**Basic concepts of development:** Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants imprinting; mutants and transgenic analysis of development.

### **UNIT-II**

**No. of Hours: 09**

**Morphogenesis and Organogenesis in animals:** Cell aggregation and differentiation in *Dictyostelium*; Axes and Pattern formation in *Drosophila*, Amphibia and Chick; Organogenesis – Vulva formation in *Caenorhabditis elegans*, Eye lens induction, Limb development and regeneration in vertebrates; Differentiation of neurons, Post - embryonic development – Larval formation, Metamorphosis; Environmental regulation of normal development; Sex determination.

**UNIT-III****No. of Hours: 09**

**Morphogenesis and organogenesis in plants:** Organization of shoot and root apical meristem; Shoot and root development; Leaf development and Phyllotaxy; Transition to flowering, Floral meristems and Floral development in *Arabidopsis* and *Antirrhinum*.

**UNIT-IV****No. of Hours: 09**

**Gametogenesis, fertilization and early development-**Production of gametes, Cell surface molecules in sperm - egg recognition in animals; Embryo sac development and Double fertilization in plants; Zygote formation, Cleavage, Blastula formation, Embryonic fields, Gastrulation and formation of germ layers in animals; Embryogenesis, Establishment of symmetry in plants; seed formation and germination.

**UNIT-V****No. of Hours: 09**

**Genes and development** - Nuclear transplantation, Differential gene activation, Developmental genetic defects, Role of cell death in development, Factors involved in Teratogenesis Programmed cell death, Ageing and Senescence.

**Text Books:**

1. Gilbert.S.F & Knisely. K.(2009).*Developmental Biology*: Sinauer Associates, Inc.
2. Hake,S &Wilt,F.(2003).*Principles of Developmental Biology*: W.W. Norton& Co.
3. Hodge,R.(2009).*Developmental Biology(Geneticsand Evolution)*:Factson File.
4. Subramanian, M.A.(2012).*Developmental Biology*: MJP Publications.

**Reference Books:**

1. Wolpert,L., Beddington ,R., Jessell,T., Lawrence, P., Mayerowitz, E.& Smith, J.(2002). *Principles of development*. UK: Oxford University Press.
2. Jonathan M. W.Slack, (2006).*Essential Developmental Biology*: Blackwell Publishing Ltd.
3. Minelli, A. (2009). *Forms of Becoming: The Evolutionary Biology of Development*: Princeton, University Press.

**Web Sources:**

1. <https://organismalbio.biosci.gatech.edu/>
2. <https://www.britannica.com/>
3. <https://www.studocu.com/>
4. <https://scialert.net/>

**SEMESTER – I**  
**23P1MBPC01**  
**Credits–2**

**Professional Competency Course**  
**Total Number of Hours: 30**  
**2Hours/Week**

## **ENTREPRENEURSHIP IN BIOBUSINESS**

### **Course Objectives:**

- Understand the basic concepts of Biobusiness and the funding for entrepreneurship.
- Explore the entrepreneurial opportunities in agricultural biotechnology.
- Understand the entrepreneurial opportunities in Industrial biotechnology
- Gain knowledge about the entrepreneurial opportunities in therapeutic and pharmaceutical products
- Learn how to initiate startup schemes, obtain subsidies and manage projects

### **Course Outcome:**

<b>CO1</b>	Explain the basic concepts of bio-business and the funding for entrepreneurship
<b>CO2</b>	Discuss and identify the entrepreneurial opportunities in agricultural biotechnology
<b>CO3</b>	Detail and analyze the entrepreneurial opportunities in Industrial biotechnology
<b>CO4</b>	Analyze the entrepreneurial opportunities in therapeutic and pharmaceutical products
<b>CO5</b>	Apply for grants and subsidies to start bio-business

### **UNIT-I**

**No. of Hours: 06**

**Bio Entrepreneurship** - Introduction to bio-business, SWOT analysis of bio-business. Ownership. Development of Entrepreneurship. Stages in entrepreneurial process. Government schemes and funding. Small scale industries-Definition, characteristics, need and rationale.

### **UNIT-II**

**No. of Hours: 06**

**Entrepreneurship opportunity in agricultural biotechnology** - Business opportunity, Essential requirement, marketing, strategies, schemes, challenges and scope. Case study on Plant cell and tissue culture technique, poly house culture. Herbal bulk drug production, nutraceuticals, value added herbal products. Bio-ethanol production using agricultural waste, algal source. Integration of system biology for agricultural applications. Biosensor development in agri management.

### **UNIT-III**

**No.of Hours:06**

**Entrepreneurship opportunity in industrial biotechnology**-Business opportunity, Essential requirement, marketing strategies, schemes, challenges, and scope. Pollution monitoring and Bioremediation or Industrial pollutants. Integrated compost production-microbe enriched compost. Biopesticide/insecticide production. Biofertilizers. Single cell protein.

### **UNIT-IV**

**No .of Hours:0 6**

**Therapeutic and Fermented products**- Stem cell production, stem cell bank, production of monoclonal/polyclonal antibodies, secondary metabolite production– antibiotics, probiotic and prebiotics.

### **UNIT-V**

**No. of Hours :06**

**Project Management, Technology Management and Startup Schemes**-Building Biotech business challenges in Indian context - biotech partners (BIRAC, DBT, Incubation centers. etc.), operational biotech parks in India. Indian Company act for Biobusiness - schemes and subsidies. Project proposal preparation, Successful start-ups-case study.

### **Text Books**

1. Shimasaki C.(2014). Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies-Academic Press.ISBN:978-0-12-404730-3
2. Acton A.Q.(2021).Biological Pigments- Advances in Research and Application- (Scholarly Editions).Atlanta, Georgia. ISBN:978-1-481-68574-0
3. Stanbury P.F. and Whitekar. A. Principles of Fermentation Technology, (3<sup>rd</sup>Edition). Butterworth-Heinemann.ISBN10:0080999530
4. Anil Kumar (2020).Small Business and Entrepreneurship, Willey Distributions, Dream Tech Press
5. Angi Redy(2015).An Unfinished Agenda.ISBN139780670087808.

### **Reference Books**

1. Crueger, W, and Crueger. A.(2017). Biotechnology: A Text Book of Industrial Microbiology. (2<sup>nd</sup>Edition).Medtech. ISBN-10:9385998633
2. Teng P.S.(2008). Bioscience Entrepreneurship in Asia. World Scientific Publishing Company. 2008.
3. Agarwal S., Kumari S and Khan S. (2021). Bio entrepreneurship and Transferring Technology into Product Development. Business Science Reference.ISBN-10:1799874125
4. Krishnamurthy A.G. Dirubai Ambani Against All Odds. McGraw Hills.
5. Peter F. Drucker. Innovation and Entrepreneurship (1985).

## Web Sources:

1. <https://www.profitableventure.com/biotech-business-ideas/>
2. <https://www.bio-rad.com/webroot/web/pdf/lse/literature/Biobusiness.pdf>
3. <https://www.nature.com/articles/s41587-021-01110-3>
4. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3003900/>
5. <https://springhouse.in/government-schemes-every-entrepreneur/>



**SEMESTER – I**  
**23P1MBAC01**  
**Credits–2**

**AECC – I**  
**Total Number of Hours:30**  
**2 Hours/Week**

## **HUMAN ANATOMY AND PHYSIOLOGY**

### **Course Objectives:**

- Imparts a fundamental knowledge on the structure and functions of the human body and outline the digestive system.
- Provides with a basic knowledge and understanding about the muscular system.
- Acquire knowledge about the respiratory system.
- Gains insight about the structure and functions of the Nervous system
- Understand the structure and functions of the Urinary system

### **Course Outcome:**

<b>CO1</b>	Explain the anatomy and physiology of human body and the digestive system
<b>CO2</b>	Detail about the structure and function of the muscular system.
<b>CO3</b>	Explain the structure and function of the respiratory system.
<b>CO4</b>	Describe the structure and function of the Nervous system.
<b>CO5</b>	Elucidate the structure and function of the Urinary system.

### **UNIT-I**

**No. of Hours:06**

**An Introduction to Human body** - Overview of level of organization and characteristics – Digestive system - Components of digestive system (GI tract and accessory organs) and their functions.

### **UNIT-II**

**No. of Hours: 06**

**Muscular system-** Muscle tissue- types (Skeletal, smooth and cardiac)-functions and properties. Neuro muscular junction.

**UNIT-III****No. of Hours:06**

**Respiratory system-** Anatomy-External and internal respiration. Cardiovascular system-Anatomy of heart, Cardiac cycle and ECG.

**UNIT-IV****No. of Hours:06**

**Nervous system-**CNS and ANS Organization -Neuron- Structure and functions-Neuro transmitters and signal transmission. Anatomy and physiology of endocrine glands - Classification of hormones - General properties and action of pituitary, thyroid, parathyroid, pancreatic hormones and gonads.

**UNIT-V****No. of Hours:06**

**Urinary system** - External and Internal anatomy of kidneys - nephron - parts and functions. Mechanism of urine formation. Reproductive system-Anatomy and physiology of male and female reproductive organs.

**Reference Books**

1. Gerard J. Tortora, BryanH. Derrickson (2014) Principles of anatomy and physiology, John wiley and sons Inc;10thEdition.
2. A.C. Guyton(2010)Text Book of Medical physiology,Saunders;12thedition.
3. K. Sembulingam and Prema Sembulingam (2012) Essentials of medical physiology- Jaypee brothers Medical publishers (P)Ltd;6thEdition.
4. DU Silverthorn (2015)Human physiology-An integrated approach, Pearson;7thedition.

# SEMESTER II

**SEMESTER-II**  
**23P2MBC03**  
**Credits-4**

**Core- III**  
**Total Number of Hours: 60**  
**6 Hours/Week**

## **MEDICAL BACTERIOLOGY AND MYCOLOGY**

### **Course Objectives**

- Acquire Knowledge on collection transportation and processing of various kinds of clinical specimens
- Explain about bacterial pyogenic infections, respiratory diseases and sexually transmitted diseases.
- Discuss about bacterial diarrhoeal diseases, Bacterial Food poisoning, UTI, Anaerobic infections, Zoonoses.
- Acquire knowledge on fungal diseases, laboratory diagnosis, antifungal agents and their sensitivity testing methods.
- Describe the pathogenesis of mycoses and mycotoxicoses.

### **Course Outcome**

<b>CO1</b>	Collect, transport and process of various kinds of clinical specimens.
<b>CO2</b>	Analyze various bacterial infections, Respiratory diseases and sexually transmitted diseases.
<b>CO3</b>	Discuss various bacterial diarrhoeal disease, Food poisoning, UTI, Anaerobic infections, Zoonoses and Nosocomial infections.
<b>CO4</b>	Employ various methods to detect fungi in clinical samples, immunodiagnosis and apply knowledge on antifungal agents and testing methods.
<b>CO5</b>	Analyze the pathogenesis and laboratory diagnosis of various mycoses and mycotoxicoses.

### **UNIT-I**

**No. of Hours:12**

**Infection:** types, mode of transmission, source, reservoir, Carriers, mechanism of bacterial pathogenesis, Normal flora of human body, Collection, transport and microbiological examination of clinical specimens- Urine, Pus, Sputum, Throat swab, Stool, CSF . Antibiotics- Classification and mode of action, Antibioqram, Antimicrobial resistance mechanism.

**UNIT-II****No .of Hours:12**

**Pyogenic infections-***Staphylococcus and Streptococcus*. Bacterial Respiratory diseases- Streptococcal Pneumonia, Diphtheria, Tuberculosis, Whooping cough, Sexually transmitted diseases-Gonorrhoea, Syphilis,

**UNIT-III****No. of Hours:12**

**Bacterial Diarrhoeal diseases-** Shigellosis and Cholera. Bacterial food poisoning, UTI, Enteric fever, Anaerobic infections- Gas gangrene, Tetanus. Bacterial zoonoses- Anthrax, Plague, Leptospirosis. Nosocomial infections-prevention and control.

**UNIT-IV****No. of Hours:12**

**Classification of mycoses:** Collection and examination of clinical specimens for mycoses. Fungal wet mount – KOH, LPCB, CFW, Indian ink. Fungal staining – GMS, H& E, PAS. Fungal culture medium. Mycological techniques. Diagnostic methods in mycology-Recent advancements in diagnosis. Antifungal agents, Antifungal Testing methods.

**UNIT-V****No .of Hours:12**

**Superficial cutaneous mycoses:** – Dermatophytoses. Subcutaneous mycoses- Maduramycoses, Sporotrichosis, Systemicmycoses, Histoplasma, Coccidioides, Blastomycoses., *Candida albicans*, *Cryptococcus neoformans*. Opportunistic mycoses- Aspergillosis. Mycotoxicoses.

**Text Books**

1. Kanunga R.(2017). Ananthanarayanan and Panicker's Textbook of Microbiology.(2017).Orient Longman, Hyderabad.
2. Green wood,D., Slack, R.B. and Peutherer, J.F.(2012)Medical Microbiology,(18<sup>th</sup> Edition).Churchill Livingstone, London.
3. Finegold, S. M. (2000) Diagnostic Microbiology, (10<sup>th</sup>Edition). C.V. Mosby Company, St.Louis.
4. Alexopoulos C.J., Mims C.W. and Blackwell M.(2007).Introductory Mycology,(4<sup>th</sup>Edition).Wiley Publishers.
5. ChanderJ.(2018).Textbook of Medical Mycology.(4<sup>th</sup>Edition).Jaypee brothers Medical Publishers.

## Reference Books

1. Salle A.J. (2007). Fundamental Principles of Bacteriology. (4<sup>th</sup>Edition). Tata McGraw-Hill Publications.
2. Collee J. C. Duguid J.P. Foraser, A.C, Marimon B.P, (1996). Mackie& Mc Cartney Practical Medical Microbiology.14<sup>th</sup> edn, Churchill Livingston
3. Cheesbrough M. (2006).District Laboratory Practice in Tropical countries.- Part22<sup>nd</sup> edn. Cambridge University Press.
4. Topley and Wilson's. (1998).Principles of Bacteriology.9<sup>th</sup>edn. Edward Arnold, London.
5. MurrayP.R., Rosenthal K.S. and Michael A.(2013). Medical Microbiology. P faller. 7<sup>th</sup>edn. Elsevier, Mosby Saunders.

## Web Sources:

1. <http://textbookofbacteriology.net/nd>
2. <https://microbiologysociety.org/members-outreach-resources/links.html>
3. <https://www.pathselective.com/micro-resources>
4. <http://mycology.cornell.edu/fteach.html>
5. <https://www.adelaide.edu.au/mycology/>

**SEMESTER-II**  
**23P2MBC04**  
**Credits-4**

**Core: IV**  
**Total Number of Hours:60**  
**6Hours/Week**

## **MICROBIAL GENETICS AND RECOMBINANT DNA TECHNOLOGY**

### **Course Objectives**

- Provide knowledge on central dogma of life processes.
- Discuss the gene regulatory mechanisms in prokaryotes and eukaryotes and molecular basis of mutation and DNA repair mechanism.
- Provide in depth knowledge on advanced techniques in genetic engineering.
- Impart knowledge on various molecular techniques and their importance in rDNA technology.
- Explain the applications of genetic engineering in various fields.

### **Course Outcome**

<b>CO1</b>	Analyze demonstrate and appreciate DNA replication and protein synthesis.
<b>CO2</b>	Investigate the types of mutation and its impact on gene regulatory mechanism ,mutation and repair mechanism
<b>CO3</b>	Illustrate various strategies on gene cloning, gene transfer mechanism and screening of recombinants.
<b>CO4</b>	Illustratively assess the molecular techniques for DNA and protein analysis.
<b>CO5</b>	Adopt the applications of Genetic Engineering in the field of agriculture and medicine Towards scientific research.

### **UNIT-I**

**No .of Hours: 12**

**DNA replication**– modes and enzymes involved. Detailed mechanism of semi-conservative replication. Prokaryotic and Eukaryotic transcription. Structure and processing of m-RNA, r-RNA and t-RNA. Ribosomes .Genetic Code and Wobble hypothesis, Translation in Prokaryotes and Eukaryotes, Posttranslational modifications.

### **UNIT-II**

**No. of Hours: 12**

**Gene regulation and expression** – Lac operon, Arabinose and Tryptophan operons. Gene regulation in eukaryotic systems-repetitive DNA, gene rearrangement, promoters, enhancer elements. Molecular basis of gene mutation - Types of mutations - Chemical mutagenesis. Detection and analysis of mutations (Replica plating, Antibiotic enrichment, Ames test). Repair of DNA damage. Photo reactivation. SOS repair mechanism. Base excision repair. Nucleotide excision repair.

### **UNIT-III**

**No. of Hours: 12**

**Tools and methods in gene cloning:** Restriction endonucleases – nomenclature, classification and characteristics - DNA methylases, DNA polymerases, Ligases. Adapters, linkers and homopoly mერთailing. Artificial gene transfer techniques - Screening for recombinants. Gene cloning vectors for prokaryotes and eukaryotes-cloning properties and types of plasmids vectors(pBR322 and derivatives, pUC vectors and pGEM3Z) - Phage Vectors (M13 and Lambda), cosmids, phasmids, phagemids and BACs - Eukaryotic vectors -Yeast vectors – Animal and plant vectors – expression vectors. Shuttle vectors.

### **UNIT-IV**

**No. of Hours: 12**

**Genomic DNA and cDNA library** - Construction and Screening. DNA cloning-Hybrid arrested translation (HAT)-Restriction mapping-restriction fragmentlength polymorphism (RFLP)-Polymerase chain reaction (PCR) – Principles, types and their applications. DNA sequencing -Primer walking, Sanger’s method and automated sequencing methods. Pyrosequencing – DNA chips and micro array.

### **UNIT-V**

**No. of Hours:12**

**Applications of animal cell cultures:** Serum protein media viability and cytotoxicity. Applications of Genetic Engineering – transgenic animals, Recombinant Cytokines and their use in the treatment of animal infections. Monoclonal Antibodies in Therapy- Vaccines and their Applications in Animal Infections -Human Gene Therapy - Germline and Somatic Cell Therapy - Ex- vivo Gene Therapy .In –vivo GeneTherapy. Vectorsin Gene Therapy-Viral and Non-Viral Vectors. Transgenic Plants.

### **Text Books**

1. Malacinski G.M. (2008). Freifelder’s Essentials of Molecular Biology. (4<sup>th</sup>Edition). Narosa Publishing House, NewDelhi.
2. Snusted D.P. and Simmons M.J.(2019). Principles of Genetics.(7<sup>th</sup>Edition). John Wiley and Soms, Inc.
3. DaleJ.W.,Schantz M.V.and PlantN.(2012).From Gene to Genomes– concepts and Applications of DNA Technology.(3<sup>rd</sup>Edition).John Wileys and Sons Ltd.
4. Primrose S.B.a nd Twyman R.M. (2006).Principles of Gene Manipulation and Genomics.(7<sup>th</sup>Edition).Blackwell Publishing.
5. Maloy S. R. Cronan J.E.Jr. and Freifelder D.(2011).Microbial Genetics.(2<sup>nd</sup>Edition). Narosa Publishing House Pvt .Ltd.



## **Reference Books**

1. Brown T.A. (2016).Gene Cloning and DNA Analysis- An Introduction. (7<sup>th</sup>Edition). John Wiley and Sons, Ltd.
2. Glick B.R. and Patten C.L.(2018). Molecular Biotechnology– Principles and Applications of Recombinant DNA. (5<sup>th</sup>Edition).ASM Press.
3. Russell P.J.(2010).Genetics-A Molecular Approach.(3<sup>rd</sup> Edition).Pearson New International Edition.
4. SynderL., Peters J. E., Henkin T.M. and Champness W. (2013).Molecular Genetics of Bacteria. (4<sup>th</sup>Edition).ASM Press Washington-D.C.ASM Press.

## **Web Sources:**

1. <https://microbenotes.com/gene-cloning-requirements-principle-steps-applications/>
2. <https://geneticeducation.co.in/what-is-transcriptomics>
3. <https://www.molbiotools.com/usefullinks.html>
4. <https://geneticeducation.co.in/what-is-transcriptomics>
5. <https://courses.lumenlearning.com/boundless-biology/chapter/dna-replication/>

## **PRACTICAL-II**

### **(MEDICAL BACTERIOLOGY AND MYCOLOGY & MICROBIAL GENETICS AND RECOMBINANT DNA TECHNOLOGY PRACTICALS)**

#### **Course Objectives**

- Develop skills in the laboratory diagnosis of bacterial infections and antimicrobial sensitivity.
- Impart knowledge on the laboratory diagnosis of fungal infections.
- Enable to isolate and estimate the DNA and RNA from bacteria and yeast
- Illustrate the significance of artificial transformation, mutations and protein separation.
- Demonstrate blotting techniques and PCR.

#### **Course Outcome**

<b>CO1</b>	Identify medically important bacteria from the clinical samples by staining and biochemical tests. Perform antibiotic sensitivity tests.
<b>CO2</b>	Identify medically important fungi from the clinical samples by KOH mount, LPCB staining and culture.
<b>CO3</b>	Perform DNA, RNA extraction and quantify.
<b>CO4</b>	Utilize various molecular techniques for gene transformation, mutation, mutant detection and SDS-PAGE.
<b>CO5</b>	Appreciate and undertake novel research with techniques like PCR and blotting analysis.

- Staining of clinical specimens- Wet mount, Differential and Special staining methods.
- Isolation and identification of bacterial pathogens from clinical specimens
- cultivation in basal, differential, enriched, selective and special media
- Biochemical identification tests.
- Enumeration of bacteria in urine to detect significant bacteriuria. Antimicrobial sensitivity testing
- Kirby Bauer method and Stokes method.
- Minimum inhibitory concentration (MIC) test.
- Minimum bactericidal concentration(MBC) test.
- Identification and Classification of common fungi.

- Examination of different fungi by Lactophenol cotton blue staining.
- Examination of different fungi by KOH staining.
- Cultivation of fungi and their identification -*Mucor*, *Rhizopus*, *Aspergillus*, *Penicillium* identification of Dermatophytes.
- Isolation of genomic DNA from *E. coli* and analysis by agarose gel electrophoresis
- Estimation of DNA using colorimeter (Diphenylamine reagent)
- Plasmid DNA isolation from *E.coli*. RNA isolation from yeast.
- RNA estimation by Orcinol method
- Artificial Transformation-Detection of UV induced and antibiotic resistant mutants by replica plating method.
- Separation of proteins by polyacrylamide gel electrophoresis(SDS-PAGE)
- Amplification of DNA by PCR
- Western blotting–Southern blotting–Demonstration only.

### **Text Books**

1. Collee J. G., Fraser A.G. Marmion B. P. and Simmons A. (1996). Mackie & Mc Cartney Practical Medical Microbiology.(14<sup>th</sup>Edition). Elsevier, New Delhi.
2. Cullimore D. R. (2010). Practical Atlas for Bacterial Identification. (2<sup>nd</sup>Edition). -Taylor & Francis.
3. Russell P.J. (2019). Genetics– A Molecular Approach (3<sup>rd</sup>Edition). Pearson Education, Inc.
4. Glick B. R. and Patten C. L. (2018). Molecular Biotechnology – Principles and Applications of Recombinant DNA (5<sup>th</sup>Edition). ASM Press.
5. Gunasekaran P. (2007).Laboratory Manual in Microbiology. New Age International.

### **Reference Books**

1. Chart H. (2018).Practical Laboratory Bacteriology. CRC Press.
2. Moore V. A. (2017). Laboratory Directions for Beginners in Bacteriology. Triste Publishing Ltd.
3. Cheesbrough M.(2006).District Laboratory Practice in Tropical countries.- Part 22<sup>nd</sup> Edition. Cambridge University Press.
4. Murray P.R., Rosenthal K.S. and Michael A. (2013). Medical Microbiology.Pfaller.7<sup>th</sup>Edition. Elsevier, Mosby Saunders
5. Maloy S. R., Cronan J.E. Jr. and Freifelder D. (2011). Microbial Genetics. (2<sup>nd</sup>Edition).Narosa Publishing Home Pvt Ltd.

**SEMESTER-II**  
**23P2MBDE05**  
**Credits-4**

**ELECTIVE: III**  
**Total Number of Hours:60**  
**4 Hours/Week**

## **CLINICAL AND DIAGNOSTIC MICROBIOLOGY**

### **Course Objectives:**

- Describe appropriate safety protocol and laboratory techniques for handling specimens and biomedical waste management.
- Develop working knowledge of techniques used to identify infectious agents in the clinical microbiology lab.
- Elucidate various diagnostic procedures in microbiology.
- Acquire knowledge on different methods employed to check antibiotic sensitivity.
- Gain knowledge on hospital acquired infections and their control measures.

### **Course Outcome:**

<b>CO1</b>	Apply Laboratory safety procedures and hospital waste disposal strategies.
<b>CO2</b>	Collect various clinical specimens, handle, preserve and process safely.
<b>CO3</b>	Identify the causative agents of diseases by conventional and molecular methods following standard protocols.
<b>CO4</b>	Assess the antimicrobial susceptibility pattern of pathogens.
<b>CO5</b>	Trace the sources of nosocomial infection and recommend control measures.

### **UNIT-I**

**No. of Hours: 12**

Microbiology Laboratory Safety Practices-General Safety Guidelines, Handling of Biological Hazards, Infectious health care waste disposal - Biomedical waste management, Emerging and Re-emerging infections.

### **UNIT-II**

**No. of Hours:12**

Diagnostic procedures-General concept of Clinical specimen collection, transport, storage and general processing in Microbiology laboratory-Specimen acceptance and rejection criteria.

### **UNIT-III**

**No. of Hours: 12**

Diagnosis of microbial diseases - Clinical, differential, Microbiological, immunological and molecular diagnosis of microbial diseases. Modern and novel microbial diagnostic methods. Automation in Microbial diagnosis.

**UNIT-IV****No. of Hours: 12**

Antibiotic sensitivity tests - Disc diffusion - Stokes and Kirby Bauer methods, E test - Dilution –Agardilution & broth dilution-MBC/MIC- Quality control for antibiotics and standard strains.

**UNIT-V****No. of Hours: 12**

Nosocomial infections–common types, sources, reservoir and mode of transmission, pathogenesis and control measures. Hospital Infection Control Committee (HICC) – Functions.

**Text books**

1. Collee J. G., Fraser A.G. Marmion B. P. and Simmons A. (1996). Mackie & McCartney Practical Medical Microbiology. (14<sup>th</sup> Edition). Elsevier, New Delhi. ISBN-10:0443047219/ ISBN-13-978-0443047213.
2. Tille P.M. (2021). Bailey and Scott's Diagnostic Microbiology. (15<sup>th</sup> Edition). Elsevier. ISBN:9780323681056.
3. Jawetz E., Melnick J.L. and Adelberg E.A.(2000). Review of Medical Microbiology. (19<sup>th</sup> Edition). Lange Medical Publications, U.S.A.
4. Mukherjee K.L. (2000). Medical Laboratory Technology.Vol.1-3. (2<sup>nd</sup> Edition). Tata McGraw-Hill Education. ISBN-10:0074632604.
5. Sood R. (2009). Medical Laboratory Technology–Methods and Interpretations. (6<sup>th</sup> Edition). Jaypee Brothers Medical Publishers (P) Ltd. New Delhi. ISBN: 9788184484496.

**Reference books**

1. Murray P. R., Baron E. J., Jorgenson J. H., Pfaller M. A. and Tenover F.C. (2003). Manual of Clinical Microbiology. (8<sup>th</sup> Edition). American Society for Microbiology, Washington, DC. ISBN:1-555810255-4.
2. Bennett J.E., Dolin R. and Blaser M.J.(2019). Principles and Practice of Infectious Diseases. (9<sup>th</sup> Edition). Elsevier. E Book ISBN: 9780323550277. Hardcover ISBN: 9780323482554.
3. Ridgway G. L., Stokes E. J. and Wren M. W. D. (1987). Clinical Microbiology 7<sup>th</sup> Edition. Hodder Arnold Publication. ISBN-10:0340554231/ISBN-13:9780340554234.
4. Koneman E.W., Allen S. D., Schreckenber P. C. and Winn W. C. (2020). Koneman's Color Atlas and Textbook of Diagnostic Microbiology. (7<sup>th</sup> Edition). Jones & Bartlett Learning. ISBN: 12843223789781284322378.
5. Cheesbrough, M. (2004). District Laboratory Practice in Tropical Countries - Part 2, (2<sup>nd</sup> Edition). Cambridge University Press. ISBN-13:978-0-521-67631-1/ISBN-10:0-521-67631-2.

**Web sources:**

1. <https://www.ncbi.nlm.nih.gov/books/NBK20370/>
2. <https://www.msdmanuals.com/en-in/home/infections/diagnosis-of-infectious3disease/diagnosis-of-infectious-disease>
3. <https://journals.asm.org/doi/10.1128/JCM.02592-20>
4. <https://www.sciencedirect.com/science/article/pii/S2221169116309509>
5. [http://www.textbookofbacteriology.net/normalflora\\_3.html](http://www.textbookofbacteriology.net/normalflora_3.html)

## BIOREMEDIATION

### Course Objectives:

- Describe the nature and importance of bioremediation and use in real world applications.
- Describe the role of microbes in aerobic digestion in different water systems and considerations for its digest or designs.
- Explain the composting, anaerobic digestion and bioremediation of various compounds.
- Explain the potential of microbes in ore extraction and acquaint students with methods of reducing health risks caused by xenobiotics.
- Familiarize the role of plants and their associated microbes in remediation and management of environmental pollution.

### Course Outcome:

CO1	Differentiate Ex-situ bioremediation and In-situ bioremediation. Assess the roles of organisms in bioremediation.
CO2	Distinguish microbial processes necessary for the design and optimization of biological processing unit operations.
CO3	Identify, formulate and design engineered solutions to environmental problems.
CO4	Explore microbes in degradation of toxic wastes and playing role on biological mechanisms.
CO5	Establish the mechanisms of Arbuscular mycorrhizal fungi and Plant growth promoting Rhizobacteria in phytoremediation.

### UNIT-I

**No. of Hours: 12**

**Bioremediation**-process and organisms involved. Bioaugmentation-Ex-situ and in-situ processes; Intrinsic and engineered bioremediation. Major pollutants and associated risks; organic pollutant degradation. Microbial aspects and metabolic aspects. Factors affecting the process. Recent developments and significance.

### UNIT-II

**No. of Hours: 12**

**Microbes involved in aerobic and anaerobic processes in nature.** Waste Water treatment - BOD, COD, dissolved gases, total organic carbon removal. Secondary waste water treatments – use of membrane bioreactor. Aquaculture effluent treatment. Aerobic sludge and landfill leachate process. Aerobic digestion. Aerobic and anaerobic digesters–design. Various types of digester for Bioremediation of industrial effluents.

### **UNIT-III**

**No. of Hours:12**

**Composting of solid wastes**, anaerobic digestion - methane production and important factors involved, Pros and cons of anaerobic process, hydrocarbon degradation, degradation of nitro-aromatic compounds. Bioremediation of dyes, bioremediation in paper and pulp industries.

### **UNIT-IV**

**No. of Hours:12**

**Microbial leaching of ores** - process, microorganisms involved and metal recovery with special reference to copper and iron. Biotransformation of heavy metals and xenobiotics. Petroleum biodegradation - reductive and oxidative. Dechlorination. Biodegradation of plastics and superbug.

### **UNIT-V**

**No. of Hours:12**

Phytoremediation of heavy metals in soil - Basic principles of phytoremediation - Uptake and transport, Accumulation and sequestration. Phytoextraction. Phytodegradation. Phytovolatilization. Rhizo degradation. Phyto stabilization–Organic and synthetic amendments in multimetal contaminated minesites. Role of Arbuscular mycorrhizal fungi and plant growth promoting rhizo bacteria in phytoremediation.

### **Text Books**

1. Bhatia H.S. (2018). A Text book on Environmental Pollution and Control. (2<sup>nd</sup>Edition).GalgotiaPublications.
2. Chatterjee A. K. (2011). Introduction to Environmental Biotechnology. (3<sup>rd</sup>Edition).Printice-Hall,India.
3. Pichtel,J. (2014).Waste Management Practices: Municipal, Hazardous, and Industrial,2<sup>nd</sup> edition, CRC Press.
4. Liu,D.H.FandLiptak,B.G(2005).HazardousWastesandSolidWastes,LewisPublishers.
5. Rajendran, P.& Gunasekaran, P.(2006).Microbial Bioremediation.1<sup>st</sup>edition. MJP Publishers

### **Reference Books**

1. Sangeetha J., Thangadurai D., David M. and Abdullah M.A. (2016). Environmental Biotechnology: Biodegradation, Bioremediation, and Bioconversion of Xenobiotics for Sustainable Development.(1<sup>st</sup>Edition). Apple Academic Press.
2. Singh A. and Ward O.P.(2004).Biodegradation and Bioremediation. Soil Biology. Springer.
3. SinghA., Kuhad R.C., and Ward O.P.(2009). Advances in Applied Bioremediation (1<sup>st</sup>Edition). Springer-Verlag Berlin Heidelberg, Germany.
4. Atlas, R.M & Bartha, R.(2000). Microbial Ecology. Addison Wesley Longman Inc.
5. Rathoure, A.K. (Ed.).(2017). Bioremediation: Current Research and Applications.1<sup>st</sup>edition.I.K. International Publishing House Pvt. Ltd.



## **Web Sources**

1. [Bioremediation- Objective, Principle, Categories,Types, Methods, Applications \(microbe notes.com\)](#)
2. <https://agris.fao.org/agris-search>
3. <https://www.sciencedirect.com/topics/earth-and-planetary-sciences/bioremediation>
4. <https://www.intechopen.com/chapters/70661>
5. <https://microbiologysociety.org/blog/bioremediation-the-pollution-solution.html>

**SEMESTER-II**  
**23P2MBDE07**  
**Credits-4**

**ELECTIVE: IV**  
**Total Number of Hours:60**  
**4 Hours/Week**

## **NANOBIOTECHNOLOGY**

### **Course Objectives:**

- Analyze nanomaterials based on the understanding of nanobiotechnology
- Discuss the methods of fabrication of nano materials.
- Gain Knowledge on characterization of nanomaterials.
- Discover nanomaterials for targeted drug delivery.
- Explain nanomaterials in nanomedicine and environmental pollution.

### **Course Outcome:**

<b>CO1</b>	Employ knowledge in the field of nano biotechnology for development.
<b>CO2</b>	Identify various applications of nanomaterials in the field of medicine and environment.
<b>CO3</b>	Examine the prospects and significance of nano biotechnology.
<b>CO4</b>	Identify recent advances in this area and create a career or pursue research in the field.
<b>CO5</b>	Design non-toxic nanoparticles for targeted drug delivery.

### **UNIT-I**

**No. of Hours :12**

**Introduction to nano biotechnology**, Nano size-changing phenomena at nano scale, Classification of nanomaterials based on their dimensions (0D, 1D, 2D and 3D materials) and based on realization of their applications (The First, second, third and fourth generation materials), Class of nanomaterials and their applications. Need for nano materials and the risks associated with the materials.

### **UNIT-II**

**No.of Hours:12**

**Fabrication of Nanomaterials**-Top-down and Bottom-up approaches, Solid phase synthesis-milling, Liquid phase synthesis-Sol-gel synthesis, colloidal synthesis, micro emulsion method, hydro thermal synthesis and solvo thermal synthesis, Vapour/Gas phase synthesis-Inert gas condensation, flame pyrolysis, Laser ablation and plasma synthesis techniques. Microbial synthesis of nanoparticles.

### **UNIT-III**

**No. of Hours:12**

**Characterization of nanoparticles** – Based on particle size/morphology- Dynamic light scattering(DLS), Scanning electron microscopy (SEM), Transmission electron microscopy (TEM), Atomic force microscopy(AFM), Based on surface charge- zeta potential, Based on structure–X-ray diffraction(XRD), Fourier transform infrared spectroscopy(FTIR), Energy dispersive X-ray Analysis (EDX), Based on optical properties-UV–Spectrophotometer, Based on magnetic properties-Vibrating sample magnetometer(VSM).

### **UNIT-IV**

**No. of Hours:12**

**Nanomaterial based Drug delivery and therapeutics**-surface modified nano particles, MEMS/NEMS based devices, peptide/DNA coupled nanoparticles, lipid and inorganic nanoparticles for drug delivery, metal/ metal oxide nano particles as antibacterial, antifungal and antiviral agents. Toxicity of nanoparticles and Toxicity Evaluation.

### **UNIT-V**

**No. of Hours:12**

**Nanomaterials in diagnosis**-Imaging, nano sensors in detection of pathogens. Treatment of surface water, ground water and waste water contaminated by toxic metal ions, organic and inorganic solutes and microorganisms.

### **Text Books**

1. Brydson R. M., Hammond, C. (2005). Generic Methodologies for Nanotechnology: Characterization. In Nanoscale Science and Technology. John Wiley& amp; Sons, Ltd.
2. Leggett G.J., Jones R.A.L.(2005). Bio nanotechnology. In Nanoscale Science and Technology. John Wiley& amp; Sons, Ltd.
3. Mohan Kumar G.(2016).Nanotechnology: Nanomaterials and nano devices. Narosa Publishing House.
4. Goodsell D.S.(2004). Bio nanotechnology. John Wiley& amp; Sons, Inc.
5. Pradeep T. (2007). Nano: The Essentials-Understanding nanoscience and nanotechnology. Tata Mc Graw-Hill.

## Reference Books

1. Nouailhat A. (2008). An Introduction to Nanoscience and Nanotechnology, Wiley.
2. Sharon M. and Maheshwar (2012). Bio-Nanotechnology: Concepts and Applications. New Delhi. Ane books Pvt Ltd.
3. Niemeyer C.M. and Mirkin C.A. (2005). Nanobiotechnology. Wiley Interscience.
4. Rehm, B.(2006). Microbial Bio nanotechnology: Biological Self-Assembly Systems and biopolymer-Based Nanostructures. Horizon Scientific Press.
5. Reisner, D.E. (2009). Bio nanotechnology: Global Prospects. CRC Press

## Web Sources:

1. <https://www.gale.com/nanotechnology>
2. <https://www.understandingnano.com/resources.html>
3. <http://dbtnanobiotech.com/index2.php>
4. <http://www.istl.org/11-winter/internet1.html>
5. <https://www.cdc.gov/niosh/topics/nanotech/default.html>

## **POULTRY MICROBIOLOGY**

### **Course Objectives:**

- To gain the knowledge on poultry rearing and its products
- To understand about the poultry feed and its significance
- To impart knowledge about the healthcare and waste management of Poultry
- To acquire knowledge about common viral diseases affecting poultry
- To acquire knowledge about common bacterial, fungal and protozoan diseases affecting poultry

### **Course Outcome:**

<b>CO1</b>	Gain the knowledge on poultry rearing and its products
<b>CO2</b>	Understand about the poultry feed and its significance
<b>CO3</b>	Acquire knowledge about the health care and waste management of Poultry
<b>CO4</b>	Acquire knowledge about common viral diseases affecting poultry
<b>CO5</b>	Acquire knowledge about common bacterial, fungal and protozoan diseases affecting poultry.

### **UNIT-I**

**No. of Hours:12**

**Poultry houses** - Types. Poultry rearing - Methods - advantages and disadvantages. Brooding: Types of brooders; Breeding organization. Classification of poultry with respect to production characters. Cage management-Different types; Advantages and disadvantages.

### **UNIT-II**

**No. of Hours: 12**

**Poultry nutrition and feeding** - Nutrient requirements and feed formulations – Factors influencing nutrient requirements- Feed consumption- Feeding systems- Additives, pre and probiotics-supplements. Nutritional and Metabolic disorders- Rickets, Osteomalacia, Vitamin A deficiency, Vitamin E deficiency.

### **UNIT-III**

**No. of Hours: 12**

Newcastle disease- fowlpox-EDS-76 (Egg Drop Syndrome) Infectious bursal diseases (Gumborodiseases)- Infectious bronchitis- Infectious Laryngo tranchitis- Inclusion body hepatitis- Avian encephalomyelitis- Reo viral arthritis-Marek's disease- Avian lymphoid leukosis.

## UNIT-IV

No. of Hours:12

Salmonellosis-Avian coliform infection -*Staphylococci*-Avian tuberculosis-Infectious coryza -Avian streptococcal infection -Avian pasteurellosis, Psittacosis. Fungal diseases-Aspergillosis, Aflatoxicosis- Parasitic diseases -Coccidiosis, *Ascardiagalli*, Tapeworms. External parasites -Fowl ticks, Lice, Mites.

## UNIT-V

No. of Hours:12

Formation of egg in fowl - Egg structure-Physical and chemical composition. Bio-security and Principles of Disease Prevention and Management. Healthcare for common poultry diseases- Principles of Poultry Medication. Poultry Waste Management- Disposal of hatchery waste.

### Text Books:

1. Mahajan Naresh, (2015). Poultry Nutrition and Management. 1<sup>st</sup> Edition. Anmol Publications Pvt. Ltd., New Delhi.
2. Wiseman. J, and Garnsworthy. P.C., (1999). Recent Development in Poultry Nutrition.
3. Titus Harry. W and Fritz James. C (1971). The Scientific Feeding of Chickens. 5<sup>th</sup> Edition.

### Reference Books:

1. F. Jordan, M. Pattison, D. Alexander and T. Faragher. (2001). Poultry diseases. W.B Saunders London.
2. B.W. Calrek (1997). Diseases of poultry. 10<sup>th</sup> Ed., Iowa State University. Ames, Iowa. USA.
3. Reena Kandwal, (2013). Nutrient Requirements of Poultry. 3<sup>rd</sup> Edition.
4. Bell D. Donald and Weaver D. William Jr., (2007). Commercial Chicken Meat and Egg Production. 5<sup>th</sup> Edition. Springer India Pvt. Ltd., Noida.
5. Reddy Ramasubba V., and Bhosale T. Dinesh, (2004). Handbook of Poultry Nutrition. 1<sup>st</sup> Edition. International Book Distribution Co., Lucknow, India.

### Web Sources:

1. <https://www.thepoultrysite.com/>
2. <http://www.agritech.tnau.ac.in/>
3. <https://www.poultrymed.com/>
4. <https://www.inpoultry.com/>

**SEMESTER-II**  
**23P2MBDE09**  
**Credits-3**

**ELECTIVE: IV**  
**Total Number of Hours:45**  
**4 Hours/Week**

## **MARINE MICROBIOLOGY**

### **Course objectives**

- To understand the diversity of marine microbes and their roles in marine habitats.
- To gain proficiency in using sampling equipment and advanced tools for studying marine microbial diversity.
- To explore microbial growth modes and their significance in biogeochemical cycling.
- To examine the metabolic diversity of marine microbes and understand their energy-yielding processes.
- To investigate the impact of marine pollutants and explore the potential of marine microorganisms in pollution abatement.

### **Course Outcome**

CO1	Understand the basics of marine microbiology, including the types of marine microbes and their roles in marine environments
CO2	Learn how to use equipment and tools to study different types of marine microbes and their diversity
CO3	Explore how microbes grow and their importance in cycling nutrients in marine ecosystems
CO4	Understand how marine microbes function and produce energy in marine environments
CO5	Examine the impact of pollutants on marine ecosystems and explore how marine microbes can help clean up pollution and support sustainable development

### **UNIT-I**

**No. of Hours: 09**

**Introduction to Marine microbiology:** Introduction to marine microbes, Role of Microorganisms in Sea Water - Marine Habitats, Global Warming, Marine Microbial Diversity, Its role in Ecosystem & Environmental Change, Potentials of Marine Microbiology.

### **UNIT-II**

**No. of Hours:09**

Sampling equipment: water samplers, sediment, Analysis of primary productivity, Analysis of bacterial productivity, Measurement of respiration rates, Tools to study marine

microbial diversity: flow cytometry (bacteria, picoplankton, picoeukaryotes, viruses); molecular approaches such as metagenomics, community fingerprinting and Fluorescence in situ hybridization (FISH).

### **UNIT-III**

**No. of Hours: 09**

Modes of microbial growth: viable but non-culturable (VBNC) microorganisms, biofilms, microbial mats, epibiosis; the role of microorganisms in biogeochemical cycling: carbon, nitrogen, phosphorous, sulphur, iron, manganese.

### **UNIT-IV**

**No. of Hours: 09**

Physiology of marine microbes: metabolic diversity and energy yielding processes: microbial loop; marine snow; phototrophy and primary productivity, fermentation, aerobic respiration, anaerobic respiration (denitrification, sulphate reduction, methanogenesis); nitrification, annamox, sulphur oxidation, methanotrophy;

### **UNIT-V**

**No. of Hours: 09**

Effect of marine pollutants on productivity and sustainability of marine ecosystem: Effect of marine pollution (toxicity) on phytoplankton (primary producers), zooplankton, fishes, coral reefs, barnacles, crabs, mussels, humans. Minamata, itaitai diseases, neurological disorders, reproductive disorder, carcinogenesis and teratogenic effects. Environmental impact assessment(EIA). Application of marine microorganisms towards pollution abatement and sustainable development.

### **Text books**

1. "Marine Microbiology: A Monograph on Hydrobiological Methods" by H. W. Conn (1927, Macmillan Publishing Company)
2. "Introduction to Marine Biogeochemistry" by Susan Libes (2012, Academic Press)
3. "Marine Microbiology" by Colin B. Munn (2016, Garland Science)
4. "Methods in Marine Microbiology" by Paul F. Kemp (2014, Academic Press)
5. "Marine Microbiology: Ecology & Applications" by Colin B. Munn and Adelfe M. S. Rodrigues (2014, CRC Press)

### **Reference Books**

1. Hunter-Cevera, J., Karl, D. and Buckley, M., Marine Microbial Diversity: the key to Earth's habitability, American Academy of Microbiology.
2. Mitchell, R. and Kirchman, D. L. Microbial Ecology of the Oceans, Wiley- Blackwell Publishers.
3. Belkin, S. and Colwell, R. R., Ocean & health: Pathogens in the Marine Environment, Springer.



4. Meller, C. B. and Wheeler, P. A., Biological Oceanography, Wiley-Blackwell Publishers
5. Munn, C. Marine Microbiology: ecology and applications, Garland Science, Taylor and Francis group, N.Y.
6. Oliver, J. D. (1982) Taxonomic scheme for the identification of marine bacteria by Deep Sea Research Part A. Oceanographic Research Papers, 29 (6): 795 -798.

### **Web Sources**

1. Marine Microbiology - Marine Biological Laboratory:  
<https://www.mbl.edu/microbialdiversity/>
2. Marine Microbial Ecology - National Center for Biotechnology Information (NCBI):  
<https://www.ncbi.nlm.nih.gov/pmc/journals/366/>
3. Marine Microbiology - Woods Hole Oceanographic Institution:  
<https://www.whoi.edu/what-we-do/explore/research-topics/marine-microbiology/>
4. Introduction to Marine Microbiology - Marine Education Society of Australasia:  
[https://www.mesa.edu.au/marine\\_topics/microbiology.asp](https://www.mesa.edu.au/marine_topics/microbiology.asp)
5. Methods in Marine Microbiology - Protocols.io:  
<https://www.protocols.io/groups/methods-in-marine-microbiology>

## VERMITECHNOLOGY

### Course Objectives:

- Introduce the concepts of vermin composting.
- Explain the physiology, anatomy and biology of earthworms
- Acquire the knowledge of the vermicomposting process.
- Explain the troubleshooting, harvesting and packaging of vermin composts.
- Gain knowledge on applications of vermin composts and their value added products.

### Course Outcome:

CO1	Compare and contrast the uses of vermicompost to the soil.
CO2	Recommend different species of earthworms after acquiring knowledge on its biology.
CO3	Design the vermicomposting process.
CO4	Assess the Best Practices of Vermicomposting
CO5	Recommend the applications of vermicompost to different soils and for different crops.

### UNIT-I

No. of Hours: 06

**Introduction to Vermiculture**-Definition, classification, history, economic importance- Insustainable agriculture, organic farming, earthworm activities, soil fertility & texture, soil aeration, water impercolation, decomposition & moisture, bait & food and their value in maintenance of soil structure- Its role in the biotransformation of the residues generated by human activity and production of organic fertilizers. Choosing the right worm. Useful species of earth worms. Local species of earth worms. Exotic species of earthworms. Factors affecting distribution of earth worm in soil.

### UNIT-II

No. of Hours:06

**Earthworm Biology and Rearing** - Key to identify the species of earthworms. Biology of *Eisenia fetida*. a) Taxonomy Anatomy, physiology and reproduction of Lumbricidae. b) Vital cycle of *Eisenia fetida*: alimentation, fecundity, annual reproducer potential and limiting factors (gases, diet, humidity, temperature, PH, light, and climatic factors). Biology of *Eudrilus eugeniae*. c) Taxonomy Anatomy, physiology and reproduction of Eudrilidae. d) Vital cycle of *Eudrilus eugeniae*: alimentation, fecundity.

### **UNIT-III**

**No. of Hours:06**

**Vermicomposting Process** - Feeds for Vermitech systems- Animal manures- Kitchen Waste and Urban waste- Paper pulp and card board solids- Compost and waste products- Industrial Wastes. Vermicomposting Basic process- Initial pre-composting phase- Mesophilic phase- Maturing and stabilization phase- Mechanism of Earthworm action. Methods of vermicomposting- a) windrows system; b) wedge system; c) container system-pits, tanks & cement rings; commercial model; bedsorbins-top fed type, stacked type, d) Continuous flow system.

### **UNIT-IV**

**No. of Hours: 06**

**Vermicomposting** - Trouble Shooting-Temperature-Aeration- Acidity- Pests and Diseases- Ants, rodents, Birds, Centipedes, sour crop, Mite pests. Odour problems. Separation techniques- Light Separation-Sideways Separation-Vertical Separation-Gradual transfer. Harvesting Earthworms-manual method- migration method. Packing & Nutritional analysis of vermicompost.

### **UNIT-V**

**No. of Hours: 06**

Applications of Vermiculture- Vermiculture Bio-technology, use of vermin castings in organic farming /horticulture, as feed/ bait for capture/culture fisheries; forest regeneration .Application quantity of vermin compost in Agricultural fields- crops, fruits, vegetables & flowers. By-products and value-added products- Vermiwash- vermicompost tea- vermimeal-enriched vermicompost- pelleted vermicompost.

### **Text Books**

1. Mail S.A. (2005).The Earthworm Book, Second Revised Edition. Other IndiaPress, Goa, India.
2. Rathoure A. K., Bharati P. K. and Ray J. (2020). Vermitechnology, Farm and Fertilizer. Vermitechnology, Farm and Fertilizer Discovery Publishing House Pvt Ltd.
3. ChristyM.V.2008.Vermitechnology, (1<sup>st</sup>Edition),MJP Publishers.
4. The complete technology book on Vermiculture and Vermicompost with manufacturing Process, machinery equipment details and Plant Layout. ABPress.
5. Keshav Singh (2014). A Textbook of vermicompost: Vermiwash and Biopesticide.

### **Reference Books**

1. RoyD. (2018). Handbook of Vermitechnology. Lambert Academic Publishing.
2. Kumar A. (2005). Verms and Vermi technology, A.P.H. Publishing Corporation, New Delhi.
3. Lekshmy M.S., SanthiR. (2012). Vermi technology, Sara Publications, NewDelhi, India.
4. [EdwardsCA](#), [AranconNQ](#) [Sherman RL](#). (2011) Vermiculture Technology: Earthworms, Organic Wastes, and Environmental Management 1<sup>st</sup>edn.CRCPress.
5. Ismail, S.A. (1997). Vermicology-TheBiologyofEarthworm.1<sup>st</sup> edn. Orientlongman.

### **Web Sources:**

1. <https://en.wikipedia.org/wiki/Vermicompost>
2. <http://stjosephs.edu.in/upload/papers/9567411a78c63d4ccfbbe85e6aa22840.pdf>
3. [https://www.kngac.ac.in/elearning-portal/ec/admin/contents/4\\_18K4ZEL02\\_2021012803204629](https://www.kngac.ac.in/elearning-portal/ec/admin/contents/4_18K4ZEL02_2021012803204629)
4. <https://composting.ces.ncsu.edu/vermicomposting-2/>
5. <https://rodaleinstitute.org/science/articles/vermicomposting-for-beginners/>

## **EPIDEMIOLOGY**

### **Course Objectives:**

- Describe the role of epidemiology in public health.
- Explain about epidemiology tools and disease surveillance methods
- Understand the epidemiological aspects of communicable diseases of national importance
- Gain insights about the epidemiological aspects of Emerging disease threats
- National Programmes related to Communicable and Non-Communicable diseases

### **Course Outcome:**

<b>CO1</b>	Apply the knowledge acquired on concepts of epidemiology to clinical and public health environment.
<b>CO2</b>	Plan various strategies to trace the epidemiology.
<b>CO3</b>	Plan the control of communicable and non-communicable diseases.
<b>CO4</b>	Analyze the recent trends in infection
<b>CO5</b>	Employ National control programs related to Communicable and Non-Communicable diseases with the public.

### **UNIT-I**

**No. of Hours:06**

Fundamentals of epidemiology-Definitions of epidemiology-Epidemiology of infectious diseases in Public Health. Natural history of disease-Historical aspects of epidemiology. Common risk factors - Epidemiologic Triad - Agent factors, host factors and environmental factors. Transmission basics - Chain of infection, Portal of entry. Modes of transmission -Direct and indirect. Stages of infectious diseases. Dynamics of disease transmission.

### **UNIT-II**

**No. of Hours:06**

Tools of Epidemiology - Measures of Disease - Prevalence, incidence. Index case. Risk rates. Descriptive Epidemiology-Cohort studies. Surveillance strategies-Disease surveillance, geographical indication system, outbreak investigation in public health and contact investigation. Biochemical and immunological tools in epidemiology - Biotyping, Serotyping, Phage typing, FAME( Fatty acid methyl ester analysis),Curie Point PyMS (Pyrolysis Massspectrometry), Protein profiling, Molecular typing methods.

### **UNIT-III**

**No. of Hours: 06**

Epidemiological aspects of communicable diseases of national importance - Vector borne diseases in India. Diarrhoeal diseases. Zoonoses. Viral hemorrhagic fevers. Mycobacterial infections. Sexually transmitted diseases. Human Immuno deficiency Virus/Acquired Immuno deficiency Syndrome (HIV/AIDS).

#### **UNIT-IV**

**No. of Hours:06**

Epidemiological aspects of Emerging disease threats-Severe Acute Respiratory Syndrome(SARS), Covid-19, Ebola, MDR-TB, Malaria, Dengue, Swine Flu, Chikungunya. Epidemiology, prevention, and control of non-communicable diseases - Asthma, Coronary heart disease, Cancer, Diabetes mellitus, Emerging and Re-emerging non-communicable Diseases.

#### **UNIT-V**

**No. of Hours:06**

National Programmes related to Communicable and Non-Communicable diseases-National Malaria Eradication Programme, Revised National Tuberculosis Control Programme, National AIDS Control Programme, National Cancer Control Programme and National Diabetes Control Programme.

#### **Text Books:**

1. Dicker R., Coronado F., Koo. D. and Parrish. R.G.(2012). Principles of Epidemiology in Public Health Practice., (3<sup>rd</sup> Edition). CDC.
2. Gerstman B.(2013). Epidemiology Kept Simple: An Introduction to Classic and Modern Epidemiology.(3<sup>rd</sup> Edition). Wiley Blackwell.
3. Greenwood, D., Slack, R.B. and Peutherer, J.F.(2012) Medical Microbiology,(18<sup>th</sup> Edition). Churchill Livingstone, London.
4. Jawetz E., Melnick J.L. and Adelberg E.A.(2000). Review of Medical Microbiology.(19<sup>th</sup> Edition). Lange Medical Publications, U.S.A.
5. Dimmock N.J. and Primrose S.B.(1994). Introduction to Modern Virology. 5<sup>th</sup> edn. Blackwell Scientific Publishers.

## Reference Books

1. Bhopal R. S. (2016). Concepts of Epidemiology - An Integrated Introduction to the Ideas, Theories, Principles and Methods of Epidemiology. (3<sup>rd</sup> Edition). Oxford University Press, New York.
2. Celentano D.D. and Szklo M. (2018). Gordis Epidemiology. (6<sup>th</sup> Edition). Elsevier, USA.
3. Cheesbrough, M. (2004). District Laboratory Practice in Tropical Countries- Part 2, (2<sup>nd</sup> Edition). Cambridge University Press.
4. Ryan K.J. and Ray C.G. (2004). Sherris Medical Microbiology. (4<sup>th</sup> Edition), McGraw Hill, New York.
5. Topley W.W. C., Wilson, G. S., Parker M. T. and Collier L. H. (1998). Principles of Bacteriology. (9<sup>th</sup> Edition). Edward Arnold, London.

## Web Sources:

1. <https://www.scielo.br/j/rbca/a/mjDFGTtfWtBm786ZmR9TG9d/?lang=en>
2. <https://hal.archives-ouvertes.fr/hal-00902711/document>
3. <https://www.who.int/csr/resources/publications/whocdscsreph200212.pdf>
4. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7187955/>
5. [https://www.who.int/diseasecontrol\\_emergencies/publications/idhe\\_2009\\_london\\_outbreaks.pdf](https://www.who.int/diseasecontrol_emergencies/publications/idhe_2009_london_outbreaks.pdf)

# SEMESTER III



## **MEDICAL VIROLOGY AND PARASITOLOGY**

### **Course Objectives:**

- The learner will acquire knowledge about virology and parasitology, classification of viruses, parasites and their characteristics.
- The learner will gain knowledge about the medically important viruses, parasites and diseases caused by them.
- The learner acquires knowledge about different diagnostic methods of microbes.
- The learner will get updated on disease control prevention and treatment of viral and parasitic infections.

### **Course Outcome:**

<b>CO1</b>	Understand the general characteristics of Viruses and prophylaxis of viral infections
<b>CO2</b>	Understand the medically important DNAviruses, and their pathogenesis prevention and treatment
<b>CO3</b>	Understand the medically important RNAviruses, and their pathogenesis prevention and treatment
<b>CO4</b>	Understand the pathogenesis, lifecycle, prophylaxis and prevention of protozoan diseases
<b>CO5</b>	Understand about the clinically important of helminths.

### **UNIT-I**

**No. of Hours:15**

General Properties of viruses and virus multiplication. Methods of cultivation of viruses. Laboratory diagnosis of viral infection. Antiviral agents, Viral Vaccines - Immunization schedule and Interferons-Non viral agents.

### **UNIT- II**

**No. of Hours: 15**

**DNA viruses**-Pathogenesis, clinical symptoms, diagnosis, treatment and prevention of following DNA viral diseases- Poxviridae: Variola and Vaccinia, Monkeypox, Herpesviridae- Herpes simplex, Varicella Zoster, CMV, EBvirus- Adenoviridae: Human adenoviruses. Papovaviridae-Human papillomavirus (HPV), Hepadnaviridae-Hepatitis B virus.

### UNIT-III

No. of Hours:15

**RNA and Retrovirus-**Pathogenesis,clinical symptoms,diagnosis,treatment and prevention of following RNA viral diseases- Picornaviridae- Poliovirus, Reoviridae- Rotavirus, Rhabdoviridae: Rabiesvirus. Flaviviridae: Dengue and Zikavirus. Orthomyxoviridae: Influenza. Paramyxoviridae: Measles, Mumps, Nipahvirus. Filoviridae: Ebola and Marburgvirus. Coronaviridae -SARS-CoV and SARS-CoV-2. Matonaviridae: Rubella, Togaviridae- Chickungunyavirus, Retroviridae: Human Immunodeficiency virus.

### UNIT- IV

No. of Hours:15

**Medical Protozoology-** Classification of medically important Protozoa, Life cycle, pathogenesis, clinical symptoms, diagnosis, treatment and prevention of following parasitic infections-Intestinal protozoans: *Entamoeba histolytica*, *Giardia lamblia*, Genital protozoan- *Trichomonas vaginalis*; Blood and tissue protozoa: *Trypanosoma brucei*; *Leishmania donovani*, *Plasmodium falciparum* and vivax.

### UNIT- V

No. of Hours: 15

**Medical Helminthology:** Life cycle, pathogenesis, clinical symptoms, diagnosis, treatment and prevention of following parasitic infections-*Ascaris lumbricoides* (roundworm), *Ancylo stomaduodenale* (hookworm), *Taenia solium* (Pork Tapeworm), *Enterobius vermicularis*(Pinworm),*Trichiuris trichura* (whipworm),Liver fluke-Fasciolahepatica,Lung fluke-Paragonimuswestermanii. Blood fluke: *Schistosoma haematobium* Microfilaria: *Wuchereria bancrofti*. Antiparasitic drugs. Case study: Students should prepare the report about viral and parasitical seasonal infections based on the WHO statistical analysis.

### Text Books

1. Dimmock,NJ, Easton,AL ,Leppard, KN(2007).Introduction to Modern Virology.6<sup>th</sup>edition, Blackwell Publishing Ltd.
2. Carter J and Saunders V(2007).Virology: Principles and Applications. JohnWiley and Sons.3.FlintSJ, Enquist,LW, Krug,RM, Racaniello,VR, Skalka,AM (2004).Principles of Virology,
3. Molecular biology, Pathogenesis and Control.2<sup>nd</sup> edition. ASM press Washington DC.

### Reference Books

1. LevyJA, ConratHF, OwenRA. (2000).Virology.3<sup>rd</sup>edition.Prentice Hall publication, New Jersey.
2. WagnerEK, HewlettMJ.(2004). BasicVirology.2<sup>nd</sup>edition.Blackwell Publishing.
3. Mathews.(2004).Plant Virology. Hull R .AcademicPress, NewYork.
4. Nayudu MV.(2008).PlantViruses Tata Mc Graw Hill, India.
5. Parija S.C.(2013)Textbook of Medical Parasitology. 4<sup>th</sup>edition.All India Publishers and Distributors, New Delhi
6. Jagdish Chander(2012).Textbook of Medical Mycology.3<sup>rd</sup>edition. Mehta Publishers, NewDelhi.

## **Web Sources:**

1. <https://uilis.usk.ac.id/oer/files/original/f8a34eba60afba60670502bc57f5f6c4.pdf>
2. <http://www.bio-nica.info/biblioteca/White&Fenner1994.pdf>
3. <https://core.ac.uk/download/pdf/80151473.pdf>
4. [sumsc.com/download\\_center/Archive/1st/441/1.Foundation%20Block/Male/Microbiology/9-Pathogenesis%20of%20Viral%20Infection%20AK%20updated%20%281%29.pdf](sumsc.com/download_center/Archive/1st/441/1.Foundation%20Block/Male/Microbiology/9-Pathogenesis%20of%20Viral%20Infection%20AK%20updated%20%281%29.pdf)

## **SOIL AND ENVIRONMENTAL MICROBIOLOGY**

### **Course Objectives**

- To understand soil properties and their role as a habitat for microorganisms
- To learn about microbial involvement in nutrient cycles within soil ecosystems
- To explore different types of microbial interactions and their significance.
- To identify airborne microorganisms and understand their impact on health and environment.
- To study bioremediation techniques for managing environmental pollutants

### **Course outcomes**

<b>CO1</b>	Students will understand how soil properties influence microorganisms, aiding in better agriculture and environmental practices
<b>CO2</b>	Students will learn how microorganisms impact soil fertility, helping optimize agricultural methods
<b>CO3</b>	Students will grasp how microorganisms interact in ecosystems, guiding strategies for sustainable agriculture
<b>CO4</b>	Students will recognize airborne microorganisms' effects on health and environments, leading to improved air quality management
<b>CO5</b>	Students will comprehend bioremediation's role in cleaning pollutants, offering solutions for waste management and environmental protection

### **UNIT-I**

**No. of Hours:15**

**Development of Soil Microbiology** - Physical and chemical properties of soil, classification of soils - soil profile – soil microflora and soil as a natural habitat for microbes. Soil organic matters and humus, Role of microorganisms in soil fertility, Microbes in different zones of soil. Decomposition of plant and animal residues by microorganisms.

### **UNIT-II**

**No. of Hours:15**

Microorganisms in soil processes - carbon cycle-Nitrogen cycle – Phosphorus and Sulphur cycle-Nitrogen fixation–symbiotic and non-symbiotic- Microbial transformation of phosphorus, sulphur and micronutrients in soil- Rhizosphere -R: S ratio - spermosphere -phyllosphere.

**UNIT-III****No. of Hours:15**

Microbial interactions: Symbiosis, neutralism, commensalism, competition, Ammensalism, Synergism, parasitism, and predation. General account and Significance of Biofertilizers and bio control agents – Bacterial, cyanobacterial, VAM. Mass production of biofertilizer.

**UNIT-IV****No. of Hours:15**

Composition of air- Indoor, outdoor of air-Distribution and sources of air borne microorganisms. Air as a carrier of microorganisms, droplet nuclei, Dispersal of Microorganisms in air - Techniques for microbiological analysis of air. Significance of air flora in human health, hospitals, industries. Air borne diseases - list of diseases caused by bacteria, fungi, viruses. Air pollution. Air sanitation – dust control, UV radiation, bactericidal vapors, filtration, laminar air flow system (HEPA filters).

**UNIT-V****No. of Hours:15**

Waste treatment and bioremediation: Solid waste management: Sources and types of solid waste, composting, vermin composting production of biogas. Liquid waste management: Primary, secondary, and tertiary sewage treatment. Bioremediation and waste management: scope of bioremediation. Degradation of hydrocarbons, oil spills, heavy metals – Chromium, lead, and xenobiotics – PCB.

**Text Books**

1. "Soil Microbiology" by N. Subba Rao (2010, Oxford & IBH Publishing Co. Pvt. Ltd.)
2. "Microbial Ecology: Fundamentals and Applications" by Ronald M. Atlas and Richard Bartha (1998, Benjamin Cummings)
3. "Environmental Microbiology" by Ian L. Pepper, Charles P. Gerba, and Terry J. Gentry (2015, Academic Press)
4. "Microbial Interactions" by K. R. Aneja (2003, New Age International (P) Ltd. Publishers)
5. "Fundamentals of Microbial Ecology" by Thomas M. Schmidt (2014, John Wiley & Sons)
6. "Fundamentals of Microbiology" by P. R. Baveja (2017, Arya Publishing Company)
7. "Environmental Biotechnology" by A. K. Mishra (2017, I.K. International Publishing House Pvt. Ltd.)
8. "Soil Microbiology, Ecology and Biochemistry" by Eldor A. Paul (2014, Academic Press)
9. "Bioremediation: Principles and Applications" by Ronald L. Crawford and Don L. Crawford (1996, Cambridge University Press)

## Reference Books

1. Agrios, G.N., (2005). "Plant Pathology", Elsevier Academic Press, Burlington.
2. Paul, A., (2014). "Soil Microbiology, Ecology and Biochemistry", Fourth Edition, Academic Press Inc., New York.
3. Lowenfels, J. and W. Lewis, (2010). "Teaming with Microbes: The Organic Gardener's Guide to the Soil Food Web", Timber Press, Portland.
4. Sylvia, D.M., Fuhrmann, J.J., Hartel, P.G. and D.A. Zuberer, (2005). "Principles and applications of soil microbiology", Second Edition, Pearson, London.
5. Barton, L.L. and Northup, D.E., (2011). "Microbial Ecology", John Wiley & Sons, Inc., New Jersey.
6. Lebaron, P., Matheron, R., Normand, P. and Sime-Ngando, T., (2015). "Environmental Microbiology: Fundamentals and Applications", Springer, New York.
7. Mitchell, R. and Gu, J.D., (2010). "Environmental Microbiology", 2nd Edition, John Wiley & Sons, Inc., New Jersey.
8. Pepper, I.L., Gerba, C.P. and Gentry, T.J, (2015). "Environmental Microbiology", 3rd Edition, Elsevier, New York.

## Web Sources:

1. Soil Biology & Environmental Microbiology Resources - USDA Agricultural Research Service: <https://www.ars.usda.gov/northeast-area/beltsville-md-barc/beltsville-agricultural-research-center/sustainable-agricultural-systems-laboratory/docs/soil-biology-environmental-microbiology-resources/>
2. Environmental Microbiology - Microbiology Online: <https://www.microbiologyonline.org/about-microbiology/microbes-and-the-environment/environmental-microbiology>
3. Soil and Environmental Microbiology - Society for Applied Microbiology: <https://sfam.org.uk/journals/education-resource-center/soil-and-environmental-microbiology.html>

## **FOOD AND FERMENTATION TECHNOLOGY**

### **Course Objectives:**

- Understand the role of microbes in food contamination and food borne diseases & its control.
- Analysis and applying various methods of food preservation & Packaging
- Production of different fermented food materials with different raw materials.
- Analysis and understanding of food hazards and implementation of standard procedures
- Understand food laws and regulations

### **Course Outcome:**

CO1	Understand the role of microbes in food contamination and food borne diseases
CO2	Analysis and applying various methods of food preservation.
CO3	Production of different fermented food materials with different raw materials
CO4	Analysis and understanding of food hazards and implementation of standard procedures
CO5	Understand food laws and regulations

### **UNIT – I**

**No. of Hours:15**

Microbial food spoilage and contamination: Food as a substrate – Incidence and types of microorganisms in food - Contamination of foods from natural habitat (green plants, fruits, animals, sewage, soil, water, air) and handling and processing. Contamination and spoilage of food –Cereals, vegetables, fruits, poultry, fish, eggs, meat, meat products and canned foods. Food Borne Infections- Bacterial, Fungal and Food borne intoxications. Infection control and storage methods.

### **UNIT - II**

**No. of Hours: 15**

**Food Preservation technique:** Aim & Objective of preservation and Processing- Perishable and Nonperishable foods- Principle of preservation - Factors affecting preservation- High and Low temperature in preservation. Preservation by Irradiation- Methods, Measurements, dose, distribution and effect. Preservation by Drying, Preservation by salt, sugar and chemicals. Food Additives Biosensors and Recent advancements in Preservation. organic and Natural Preservatives. Different types of packing methods for preserved foods.

### **UNIT - III**

**No. of Hours:15**

**Industrial Food Fermentations:** Starter cultures their biochemical activities, production and preservation of the following fermented foods. Soy sauce fermentation by Moulds, Fermented vegetables – Sauerkraut & Pickle, Fermented Meat – Sausages, Fermented milk- cheese, Acidophilus milk and Yoghurt, Production and application of Bakers Yeast, Fermented beverages-

Beer, Wine & Vinegar. Genetically modified foods, Application of microbial enzymes in food industry.

#### **UNIT – IV**

**No. of Hours:15**

Quality Analysis of Food Hazards: Quality assurance: Microbiological quality standards of food. Government regulatory practices and policies. FDA, FSSAI, EPA, HACCP, ISI. Food adulteration and common food additives. In house Committee for quality assurance, Persons involved, Internal Microbial Quality control Policy, Quality Check at every step from collection of raw materials till it reaches the customer, Implementation of ISO standards, definitions, principles and use of HACCP in Food Industry. Detection of Adulterations in food. AI based Biosensors in food industry

#### **UNIT – V**

**No. of Hours: 15**

Food laws and regulations A. National – PFA Essential Commodities Act (FPO, MPO etc.) B. International – Codex Alimentarius, ISO – 9000 series , ISO 22000 & BS 5750. C. Regulatory Agencies – WTO Consumer Protection Act - Relevance of Microbiological standards & criteria for food safety – Sampling plans – Microbiological guidelines Hygiene and sanitation in food sector, General Principles of Food Hygiene, GHP for commodities, equipment, work area and personnel, cleaning and disinfection (Methods and agents commonly used in the hospitality industry).

#### **Text Book(s)**

1. James. M. Jay, 1992, Modern food microbiology 4ed
2. Frazier, W. C. and Westhoff D.C. 1989. Food Microbiology 8 ed
3. Stantury, P.F., Whitekar, A. and Hall, S.J., 1995, Principles of Fermentation Technology

#### **Reference Books**

1. Dubey. R.C. and Maheswari. D.K. A Textbook of Microbiology, 1999. 1ed
2. Food Microbiology. 2nd Edition – M.R.Adams&M.O.Moss – Panima Publishers
3. Robinson R. K. (2000). Dairy Microbiology 3<sup>rd</sup>edn, Elsevier Applied Science, London.
4. Adams M.R, and Moss M.D, (2005). Food Microbiology 4<sup>th</sup>edn, New Age International Pvt. Ltd., Publishers. First edition.
5. Banwarst. G.J. (2003). Basic Food Microbiology 2<sup>nd</sup>edn, CBS Publishers and distributors.
6. Hobbs, B.C. and Roberts, D, (1968), Food Poisoning and Food Hygiene 7<sup>th</sup>edn. Edward Arnold: London.
7. Vijaya R K, (2004). Food Microbiology 1<sup>st</sup>edn. MJP Publishers, Chennai

#### **Web source:**

1. Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]
2. <https://www.fssai.gov.in>
3. <https://www.fda.gov/food/hazard-analysis-critical-control-point-haccp/haccp-principles-application-guidelines>



**VIROLOGY, PARASITOLOGY, SOIL AND FOOD MICROBIOLOGY PRACTICAL-III**

<b>CO1</b>	Gain knowledge about different methods of cultivation of viruses
<b>CO2</b>	Perform Serodiagnosis of various viral diseases.
<b>CO3</b>	Apply the knowledge and perform techniques for the identification of parasites in stool and blood
<b>CO4</b>	Understand the isolation of various microbes from different soil, root nodule and diseased plants
<b>CO5</b>	Acquire knowledge about the different methods used in water quality analysis

**1. Cultivation of viruses and Serodiagnosis of various viral diseases.**

- Egg inoculation methods – (chorioallantoic membrane, allantoic cavity, amniotic sac and yolk sac.)
- Animal Tissue culture (Demonstration)
- ELISA – HBV and HIV.
- Haemagglutination and Haemagglutination Inhibition Test.

**2. Identification of parasites:**

- Saline and Iodine wet mount
- Sedimentation and Flootation techniques
- Blood smear examination for Malarial parasite

3. Isolation of Rhizosphere microorganisms, *Rhizobium*sp, *Azotobacter*sp, *Azospirillum*sp, phosphate solubilizing bacteria and Cyanobacteria from soil/ root nodule / paddy field.

4. Isolation of bacterial and fungal pathogens from diseased plants.

5. Water Quality Analysis by Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD)

- Water analysis by Most probable Number (MPN) technique.
- Water analysis by Membrane filter technique

6. Microbial assessment of air quality using air sampler

7. Isolation of cellulose degrading bacteria from compost

8. Mass production of *Azolla*, *Rhizobium*sp, *Azotobacter*sp,

9. Enumeration of microorganisms bacteria and fungi in food samples- vegetables, fruits and Bread.

10. Qualitative testing of milk by MBRT (Methylene Blue Reduction Test) & Resazurin test, breed count

11. Wine production using fruit juices- total acidity, volatile acidity and ethanol from wine

### **REFERENCE BOOKS**

1. Dubey RC and Maheshwari DK (2012). Practical Microbiology. 3rd Edition. S. Chand & Company Ltd., New Delhi.
2. Aneja KR (2010). Experiments in Microbiology, Plant pathology and Biotechnology. 4<sup>th</sup> Edition, New age International publishers, Chennai.
3. Aneja, K.R., “Experiments in Microbiology and Plant Pathology”, New Age Publications, New Delhi, 2003.
4. Benson, J.H., “Microbiological Applications: A Laboratory Manual in General Microbiology”, Eighth Edition, McGraw-Hill, New York, 2001.
5. Cappuccino, J.G. and Sherman, N., “Microbiology - A Laboratory Manual”, Eleventh Edition, Benjamin and Cummings Publications, San Francisco, 2017.
6. Dubey, R.C. and Maheswari, D.K., “Practical Microbiology”, New Age Publications, New Delhi, 2002.
7. Kannan, N., “Laboratory Manual in General Microbiology”, Fourth Edition, Palani Paramount

## **METAGENOMICS**

### **Course Objective:**

- To learn the importance of genomic world
- To know the diversity of microbes from traditional methods to metagenomic methods
- To learn the technologies behind the sequencing methods
- To learn about the analytical tools in future research

### **Course Outcome:**

<b>CO1</b>	Understand Basic methods and techniques for metagenomics study
<b>CO2</b>	Familiarize with Stable isotope probing and oligonucleotide microarrays
<b>CO3</b>	Understand Library construction and analysis of metagenomic Libraries
<b>CO4</b>	Gain knowledge about Applications of Metagenomics
<b>CO5</b>	Understand practical relevance of Metagenomics

### **UNIT - I**

**No. of Hours:12**

**Genomics to Metagenomics** - Introduction: Basic methods and techniques for metagenomics study: sequencing technology, gene-expression systems, single-cell analyses; Analysis of metagenomics data: metagenomics analysis servers, metadata, preprocessing, identifying genes, annotations Comparative metagenomics

### **UNIT - II**

**No. of Hours: 12**

**Metagenomics Data Analysis:** DNA Extraction, Quantification, Amplification, OTU, Rarefractive Curve, Computational tools used in metagenomic analysis, Data processing and visualization

### **UNIT - III**

**No. of Hours: 12**

Stable isotope probing and oligonucleotide microarrays: Next generation sequencing analysis; Direct linking of populations to biodegradation biotransformation microbial specific and processes by stable isotope probing of biomarkers- PhyloChip&GeoChip- Detection of xenobiotic-degrading bacteria by using oligonucleotide microarrays.

## **UNIT - IV**

**No. of Hours:12**

**Library construction and analysis of metagenomic Libraries:** Library Cataloging microbes: phylogenetic tree and Construction of a metagenomic library; Analysis of Metagenomic Libraries; Sequence-based Metagenomics Analysis; Function based Metagenomics Analysis; Phylogenetic analysis and Comparative genomics Software & Tools

## **UNIT - V**

**No. of Hours: 12**

**Applications of Metagenomics** - Metagenomics of the human microbiome, bio-prospecting novel genes, metagenomics for industrial bioproducts, metagenomics for bioremediation, plant-microbe interactions, metagenomics and ecosystems biology; Major stakeholders in metagenomics; Metagenomics and the convention on biological diversity.

## **REFERENCE BOOKS**

1. D. Marco (Ed.), Metagenomics: Theory, Methods and Applications, 1st Edn., Caister Academic Press, 2010.
2. W. R. Streit and R. Daniel (Eds.), Metagenomics: Methods and Protocols, 1st Edn., Humana Press, 2010
3. K. E. Nelson (Ed.), Metagenomics of the Human Body, 1st Edn., Springer, 2010.
4. D. Marco (Ed.), Metagenomics: Current Innovations and Future Trends, 1st Edn., Caister Academic Press, 2011.

## **BIOETHICS, BIOSAFETY AND IPR**

### **Course Objectives:**

- To introduce basic concepts of ethics and safety that is essential for Life Science Labs.
- To understand the procedures involved in protection of Intellectual property.
- To give an insight into different treaties signed.
- To gain knowledge about patent filing.

### **Course Outcome:**

<b>CO1</b>	Create a research environment. Encourage investigation, analysis and study the bioethical principles, values, concepts, and social and juridical implications in the areas of science, biotechnology and medicine.
<b>CO2</b>	Discuss about various aspects of biosafety regulations, IPR and bioethics concerns arising from the commercialization of biotechnological products.
<b>CO3</b>	Familiarize fundamental aspects of Intellectual property Rights in the development and management of innovative projects in industries.
<b>CO4</b>	Acquire knowledge about bioethics, biodiversity and Genetically modified foods and food crops
<b>CO5</b>	Provide students with an understanding of bioethics in research associated with medicine

### **UNIT - I**

**No. of Hours: 12**

**Intellectual Property Rights:** Different forms of Intellectual Property Rights – their relevance, importance to industry, Academia. Role of IPR's in Biotechnology, Patent Terminology - Patents, trademarks, copyrights, industrial designs, geographical indications, trade secrets, non-disclosure agreements. Patent life and geographical boundaries. International organizations and IPR - Overview of WTO, TRIPS, WIPO, GATT, International conventions, Trade agreements, Implication of TRIPS for developing countries.

### **UNIT - II**

**No. of Hours:12**

**Process involved in patenting.** Patent Search - Procedural steps in patenting, process of filing, PCT application, pre-grant & post-grant opposition, PCT and patent harmonization including Sui-generis system, patent search methods, patent databases and libraries, online tools – App based patent filing, Country-wise patent searches (USPTO, EPO, India etc.), patent mapping.

### **UNIT - III**

**No. of Hours:12**

**Patentability of Biotechnology inventions** - Patentability of biotechnology inventions in India, statutory provisions regarding biotechnological inventions under the current Patent Act 1970 (as Amended 2005). Biotechnological inventions as patentable subject matter, territorial nature of patents - from territorial to global patent regime, interpreting trips in the light of biotechnology inventions, feasibility of a uniform global patent system, merits and demerits of uniform patent law, relevance of the existing international patent, tentative harmonisation efforts, implications of setting up a uniform world patent system.

### **UNIT – IV**

**No. of Hours: 12**

**Introduction to Bioethics** - need of bioethics, applications and issues related to bioethics, social and cultural issues. Bioethics and biodiversity - conserving natural biodiversity, convention on protecting biodiversity, protocols in exchanging biological material across borders. Bioethics & GMO's - issues and concerns pertaining to genetically modified foods and food crops, organisms and their possible health implications and mixing up with the gene-pool.

### **UNIT – V**

**No. of Hours:12**

**Bioethics in Medicine** - Protocols of ethical concerns related to prenatal diagnosis, gene therapy, organ transplantation, xeno transplantation, ethics in patient care, informed consent. bioethics and cloning - permissions and procedures in animal cloning, human cloning, risks and hopes. Bioethics in research: DBT – IBSC, stem cell research, human genome project, use of animals in research, human volunteers for clinical research, studies on ethnic races. Nuremberg code DRT biosafety regulations..

### **TEXT BOOKS**

1. Usharani B., Anbazhagi S. and Vidya C. K. (2019). Biosafety in Microbiological Laboratories. (1st Edition). Notion Press. ISBN-101645878856
2. Satheesh M. K. (2009). Bioethics and Biosafety. (1st Edition). J. K International Publishing House Pvt. Ltd: Delhi. ISBN: 9788190675703
3. Goel D. and Parashar S. (2013). IPR, Biosafety and Bioethics. (1st Edition). Pearson education: Chennai. ISBN-13: 978-8131774700
4. Raj Mohan joshi. Biosafety and Bioethics. Wiley Publications.
5. Sibi. GIIntellectual, Property Rights, Bioethics, Biosafety and Entrepreneurship in biotechnology. (2021). Wiley Publications.

## **REFERENCES BOOKS**

1. Nithyananda K. V. (2019). Intellectual Property Rights: Protection and Management, India, IN: Cengage Learning India Private Limited.
2. Neeraj, P. and Khusdeep, D. (2014). Intellectual Property Rights, India, IN: PHI learning Private Limited,
3. Ahuja, V K. (2017). Law relating to Intellectual Property Rights, India, IN: Lexis Nexis.
4. Tony Hope (2004). Medical Ethics: A very Short introduction,. Oxford Publication.
5. GoelParashar. IPR, Biosafety and Bioethics (2013). Pearson Publications.

## **WEB SOURCES**

- [http://biosafetyinlab.com/public\\_html/wcontent/uploads/2019/09/ENGLaboratuvarBioguvencik.pdf](http://biosafetyinlab.com/public_html/wcontent/uploads/2019/09/ENGLaboratuvarBioguvencik.pdf)
- [https://dbtindia.gov.in/sites/default/files/uploadfiles/Guidelines%20Handbook\\_2011.pdf](https://dbtindia.gov.in/sites/default/files/uploadfiles/Guidelines%20Handbook_2011.pdf)
- [https://www.biotec.or.th/biotecen2015/images/stories/News/2015/Biosafety\\_guidelines/GMM-guidelines\\_final.pdf](https://www.biotec.or.th/biotecen2015/images/stories/News/2015/Biosafety_guidelines/GMM-guidelines_final.pdf)

## **WATER TREATMENT AND WATER POLLUTION MANAGEMENT**

### **Course Objectives:**

- Learn the importance of and impacts of water scarcity
- Know the measures taken to prevent water pollution
- To learn the technologies behind the Waste water treatment
- To learn about advanced technologies adopted for Water Treatment.

### **Course Outcome:**

<b>CO1</b>	Understand the major causes of Water Scarcity and its types
<b>CO2</b>	Understand the measures to prevent Water Scarcity
<b>CO3</b>	Understand about water contamination and different criteria to assess water quality
<b>CO4</b>	Understand about Water Treatment Technologies
<b>CO5</b>	Understand about advanced technologies adopted for Water Treatment.

### **UNIT - I**

**No. of Hours: 12**

Water Scarcity; Major Causes of Water Scarcity, Types of Water Scarcity, Water Footprint- Effects of Water Scarcity across the Globe, Water Scarcity and its effects in India - Social and Political Effects and Economic Risks of Water Scarcity in India. WRT

### **UNIT - II**

**No. of Hours:12**

Multi-pronged approach to Prevent Water Scarcity; Aquifer Recharging, Water reuse and Zero-Liquid Discharge Technology, Coastal Reservoir, Desalination Plants Measures for Preventing Water Scarcity in India - Jal Shakti Abhiyan Campaign, Atal Bhujal Yojana, Adoption of Composite Water Management Index (CWMI), Water conservation resource management, Rain Water Harvesting

### **UNIT - III**

**No. of Hours:12**

Water Quality and Pollution; Impurities in the water, Characteristics of different water sources Vulnerability of the water sources to contamination, Water quality criteria - quality of surface waters, flowing waters, impounded waters, groundwater, Water quality standards, Microbiological quality of drinking Water, Chemical quality parameters of drinking water.



## **UNIT - IV**

**No. of Hours: 12**

**Water Treatment Technologies**-Liquid waste management: Primary, secondary, and tertiary sewage treatment. Sedimentation, Filtration, Coagulation and Flocculation, Water softening and Adsorption processes, Membrane filtration, Microfiltration, Ultrafiltration and Nanofiltration, Water disinfection, Activated carbon filtration, Household Water Treatment and Safe Storage (HWTS). Assessing the impact of HWTS, Government policies for HWTS.TNPCB – 2016 norms

## **UNIT -V**

**No. of Hours:12**

New and Emerging Drinking Water Treatment Technologies; Nanotechnology, Acoustic nanotube technology, Photocatalytic water purification technology, Aquaporin Inside™ technology, Automatic Variable Filtration (AVF) technology, Sun Spring System, Desalination.

## **TEXT BOOKS**

1. Fujita K. and Mizushima T. (2021). Sustainable Development in India -Groundwater Irrigation, Energy Use, and Food Production. ISBN 9780367460976.
2. Gupta R. (2008). Water Crisis in India. Atlantic Publishers. ISBN: 9788126909582, 9788126909582.
3. Ahuja S. (2013 - 2022). Monitoring Water Quality-Pollution Assessment, Analysis, and Remediation. Elsevier. Book ISBN: 9780444594044. Hardcover ISBN: 9780444593955

## **References Books**

1. Bansil, P.C. 2004. Water Management in India. Concept Publishing Company, India.
2. Brebbia, C.A. 2013. Water Resources Management VII. WIT Press.
3. CEA. 2011. Water Resources and Power Maps of India. Central Board of Irrigation & Power.
4. Grumbine, R.E. and Pandit, M.K. 2013. Threats from India's Himalaya dams. Science 339: 36-37.
5. Loucks, D.P., Stedinger, J.R. & Haith, D. A. 1981. Water Resource Systems Planning and Analysis. Englewood Cliffs, NJ, Prentice Hall.
6. Mays, L.W. 2006. Water Resources Sustainability. The McGraw-Hill Publications.
7. Schward and Zhang, 2003. Fundamentals of Groundwater. John Willey and Sons.
8. Souvorov, A.V. 1999. Marine Ecogonomics: The Ecology and Economics of Marine Natural Resource Management. Elsevier Publications.
9. Vickers, A. 2001. Handbook of Water Use and Conservation. Water Plow Press.

## **Web References**

1. [https://vssut.ac.in/documents/syllabus-16-17/M.Tech.\\_CE\\_ESE.pdf](https://vssut.ac.in/documents/syllabus-16-17/M.Tech._CE_ESE.pdf)
2. [https://www.terisas.ac.in/uploads/1551932281\\_387671\\_NRE%20142.pdf](https://www.terisas.ac.in/uploads/1551932281_387671_NRE%20142.pdf)
3. <http://www.unipune.ac.in/dot/pdf-files/PGDWTM.pdf>
4. [https://onlinecourses.nptel.ac.in/noc22\\_ce27/preview](https://onlinecourses.nptel.ac.in/noc22_ce27/preview)
5. <https://edukemy.com/blog/water-conservation-water-scarcity-water-stress-and-water-risk-indias-water-situation-upsc-environment-notes/>

## **MICROBIAL GENOMICS**

### **Course Outcome:**

- To describe the development of Omics technologies, with emphasis on genomics
- To Synthesize information to discuss the key technological developments that enabled modern genomic and proteomic studies.
- To acquire knowledge in genome sequencing
- To describe advanced genomics and proteomics technologies and the ways in which their data are stored.
- To use bioinformatics techniques to query examples of genomic and proteomic databases to analyze cell biology.

### **Course Outcome:**

<b>CO1</b>	Describe the development of Omics technologies, with emphasis on genomics
<b>CO2</b>	Synthesize information to discuss the key technological developments that enabled modern genomic and proteomic studies.
<b>CO3</b>	Acquire knowledge in genome sequencing
<b>CO4</b>	Describe advanced genomics and proteomics technologies and the ways in which their data are stored.
<b>CO5</b>	Use bioinformatics techniques to query examples of genomic and proteomic databases to analyze cell biology.

### **UNIT - I**

**No. of Hours:12**

**Microbial Genomics**-Overview of Genomics – Genomics and significance – Human genome - Microbial Genome Structure: Prokaryotic vs. eukaryotic genomes, plasmids, and mobile genetic elements- Genome Sequencing Technologies- Sanger sequencing, Next-Generation Sequencing (NGS), and third-generation sequencing – Genome assembly and annotation- Applications of Microbial Genomics: Medicine, agriculture, environmental science, and biotechnology.

### **UNIT - II**

**No. of Hours:12**

**Techniques in Microbial Genomics** DNA Extraction and Purification: Methods and challenges- Library Preparation for Sequencing: Shotgun sequencing, mate-pair sequencing, and amplicon sequencing- Sequencing Platforms: Illumina, PacBio, Oxford Nanopore- Data Analysis Pipelines: Quality control, sequence alignment, and variant calling-Functional Genomics: Transcriptomics, proteomics, and metabolomics.

### **UNIT - III**

**No. of Hours: 12**

**Comparative and Evolutionary Genomics** Comparative Genomics: Methods for comparing genomes, synteny, and gene conservation- Phylogenomics- Phylogenetic analysis using genomic data, molecular clocks, and evolutionary models-Horizontal Gene Transfer- Mechanisms, detection, and impact on microbial evolution- Metagenomics- Principles and techniques for studying microbial communities- Pan-Genomics: Core genome vs. accessory genome, pan-genome analysis, and its implications.

### **UNIT - IV**

**No. of Hours: 12**

**Functional and Structural Genomics** Gene Prediction and Annotation- Identifying coding regions, regulatory elements, and non-coding RNAs-Protein Structure Prediction: Computational methods for predicting protein structure and function-Gene Expression Analysis: RNA-Seq, microarrays, and quantitative PCR- Epigenomics- DNA methylation, histone modification, and their role in gene regulation- Systems Biology- Integrative approaches to understanding microbial networks and pathways.

### **UNIT - V**

**No. of Hours:12**

**Microbial genome Applications** Microbial Pathogen Genomics - Genomic approaches to studying microbial pathogens and antibiotic resistance- Industrial Microbiology - Genomic strategies for improving microbial strains for industrial applications - Environmental Genomics - Microbial genomics in environmental monitoring and bioremediation - Personalized Medicine - Role of microbial genomics in human health, microbiome studies, and therapeutic development - Emerging Technologies: CRISPR/Cas9, synthetic biology, and their implications for microbial genomics.

### **REFERENCE BOOKS**

1. "Genomes" by T.A. Brown
2. "Principles of Genome Analysis and Genomics" by Sandy B. Primrose and Richard Twyman
3. "Microbial Genomics" edited by Katherine M. Eaton and Stephen J. Bentley
4. "Next-Generation DNA Sequencing Informatics" by Stuart M. Brown
5. "Comparative Genomics" edited by Nicholas H. Bergman
6. "Molecular Evolution: A Phylogenetic Approach" by Roderick D.M. Page and Edward C. Holmes
7. "Evolutionary Genomics: Statistical and Computational Methods" edited by Maria Anisimova
8. "Functional Genomics: Methods and Protocols" edited by Michael Kaufmann, Caroline Klinger, and Roland M. Eils
9. "Microbial Genomics in Sustainable Agroecosystems" edited by Vijay Tripathi and Pradeep K. Divakar
10. "Clinical Microbiology and Infectious Diseases" by W. John Spicer
11. "Synthetic Biology: A Primer" by Geoff Baldwin, Paul Freemont, Richard Kitney, and Tom Ellis

## **ORGANIC FARMING FOR SUSTAINABLE AGRICULTURE**

### **Course Objectives:**

- Impart knowledge on the importance, types and advantages of organic farming thereby creating awareness on conserving environment and natural resources, encouraging sustainable agriculture.
- Familiarize with the basic concepts of farm development and relate the development of organic farming in their countries to meet global trends.
- Explain the various types of bio fertilizer and the scope in its production.
- Discuss about biofertilizer production and its field application, promoting economy.
- Develop the skill to analyze the quality of packaging, storage, assess the shelf life and bioefficacy of biofertilizers

### **Course Outcome:**

<b>CO1</b>	Impart knowledge on the importance, types and advantages of organic farming thereby creating awareness on conserving environment and natural resources, encouraging sustainable agriculture.
<b>CO2</b>	Familiarize with the basic concepts of farm development and relate the development of organic farming in their countries to meet global trends.
<b>CO3</b>	Explain the various types of biofertilizer and the scope in its production.
<b>CO4</b>	Discuss about biofertilizer production and its field application, promoting economy.
<b>CO5</b>	Develop the skill to analyze the quality of packaging, storage, assess the shelf life and bioefficacy of biofertilizers

### **UNIT - I**

**No. of Hours:12**

**Organic farming** – Definition, relevance. Biological nutrient management- Organic manures, vermicompost, green manure, organic residue, biofertilizer soil amendments. Integrated pest and weed management - Use of biocontrol agents, bio pesticides etc. Organic and Conventional farming. Organic and Chemical farming – Comparison.

### **UNIT - II**

**No. of Hours: 12**

**Certification and Schemes** - Certification and Schemes. Organic certification in brief. Integrated farming system- definition, goal, components. Factors affecting ecological balance. Land degradation. Soil health management. Models of IFS for rainfed and irrigated conditions and different categories of farmers. Government schemes - NPOF, NPOF, NHM, HMNEH, NPMSH&F and RKVY

### **UNIT - III**

**No. of Hours:12**

**Biofertilizers** - Introduction, types, advantages and future perspective. Introduction, status and scope. Structure and characteristic features of bacterial biofertilizers- *Azospirillum*, *Azotobacter*, *Bacillus*, *Pseudomonas*, *Rhizobium* and *Frankia*. Biopesticides

### **UNIT - IV**

**No. of Hours: 12**

**Cyanobacterial biofertilizers**- *Anabaena*, *Nostoc*, *Hapalosiphon* and fungal biofertilizers- AM mycorrhiza and ectomycorrhiza. Nitrogen fixation -Free living and symbiotic nitrogen fixation. Mechanism of phosphate solubilization and phosphate mobilization, potassium solubilization.

### **UNIT - V**

**No. of Hours: 12**

**Production technology** - Strain selection, sterilization, growth and fermentation, mass production of carrier based and liquid bio-fertilizers. FCO specifications and quality control of biofertilizers. Application technology for seeds, seedlings, tubers. Biofertilizers -Storage, shelf life, quality control and marketing. Factors influencing the efficacy of biofertilizers.

### **Text Books**

1. Sharma A. K. (2001). Hand book of Organic Farming. Agrobios.
2. Gaur A. C. (2006). Hand book of Organic Farming and Biofertilizers. Ambika Book Agency.
3. Subba Rao N.S. (2017). Bio-fertilizers in Agriculture and Forestry. (4th Edition). Med Tech publisher.
4. Subba Rao N. S. (2002). Soil Microbiology. Soil Microorganisms and Plant Growth. (4th Edition). Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
5. Sathe T.V. (2004). Vermiculture and Organic Farming. Daya Publishers.

### **Reference Books**

1. Rakshit A. and Singh H. B. (2015). ABC of Organic Farming. (1st Edition). Jain Brothers.
2. Dubey R. C. (2008). A Textbook of Biotechnology. S. Chand & Co., New Delhi.
3. Bansal M. (2019). Basics of Organic Farming. CBS Publisher.
4. Bhoopander G., Ram Prasad., (2019) Biofertilizer for sustainable agriculture and Environment, Springer
5. Niir Board., (2012) (1st Edition) Biofertilizer and organic farming

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1. [https://agritech.tnau.ac.in/org\\_farm/orgfarm\\_introduction.html](https://agritech.tnau.ac.in/org_farm/orgfarm_introduction.html)  
<https://www.fao.org/organicag/oa-faq/oa-faq6/en/>
2. <https://www.india.gov.in/topics/agriculture/organic-farming>
3. <https://agriculture.nagaland.gov.in/bio-fertilizer/>
4. [https://www.ccd.ngo/sustainable-agriculture.html?gclid=EAIaIQobChMI5a-KndCo-wIV2ZZLBR1ozQj9EAAYAiAAEgJW2\\_D\\_BwE](https://www.ccd.ngo/sustainable-agriculture.html?gclid=EAIaIQobChMI5a-KndCo-wIV2ZZLBR1ozQj9EAAYAiAAEgJW2_D_BwE)

## **MICROBIAL QUALITY CONTROL AND TESTING**

### **Course Objectives**

- To Understand good laboratory practices.
- To Understand the importance of microorganism in food safety.
- To Understand the isolation and analysis of microorganisms in food
- To Understand the food safety regulation and policies
- To Understand the food laboratories, quality control agencies and their regulation in food safety

### **Course Outcome:**

<b>CO1</b>	Understand good laboratory practices.
<b>CO2</b>	Understand the importance of microorganism in food safety.
<b>CO3</b>	Understand the isolation and analysis of microorganisms in food
<b>CO4</b>	Understand the food safety regulation and policies
<b>CO5</b>	Understand the food laboratories, quality control agencies and their regulation in food safety

### **UNIT-I**

**No. of Hours:12**

**Quality control regulations and policies in food industry**-Good laboratory practices (GLP), Good Microbiological Practices (GMP). Quality policy, quality objectives of food processing company, Standard Operating Procedures, Good Handling Practices (GHP) &GMP checklist.

### **UNIT- II**

**No. of Hours: 12**

**Importance and significance of microorganisms in food safety**- Factors affecting the growth of microorganisms in food-intrinsic (pH, moisture, oxidation-reduction potential and nutrient content)andextrinsic(Temperature,relativehumidity,gasesandmicrobialactivities).

**UNIT-III****No. of Hours:12**

**Determination of microorganisms and their products in food:** sampling, sample collection, transport and storage, sample preparation for analysis. Microscopic and culture dependent methods-direct microscopic observation, culture enumeration and isolation methods.

**UNIT- IV****No. of Hours: 12**

**Food Safety:** Indicators of food microbial quality and safety-Sanitation, control and inspections. Food adulteration and types. Food safety objectives (FSO), Food safety laws and Food legislation: Principles and guidelines for conducting microbiological risk of food. Enforcement and Government Regulatory practices and policies. FDA, BIS, HACCP,

**UNIT- V****No. of Hours: 12**

**Food laboratories:** Food testing laboratories in India- NABL accreditation of microbial products, Referred food lab by FSSAI, Food testing procedure food auditing, licensing requirements.

**Text books**

1. Frazier, W.C.(1988)Food Microbiology, McGraw Hill Inc.4<sup>th</sup> Edition.
2. The training manual for Food Safety Regulators. Vol.II
3. Food Safety regulations and food safety management.(2011) Food safety and Standards Authority of India. New Delhi.
4. Fundamentals of Dairy Microbiology by Prajapati.

**Reference Books**

1. Pelczar, M.I., and Reid, R.D.(2009) Microbiology, 5<sup>th</sup>Ed., McGraw Hill Inc.,NewYork.
2. James, M.J.(2007) Modern Food Microbiology,2<sup>nd</sup>Ed.,CBS Publisher, New Delhi
3. Adams, M.R., and Moss, M.G.,(2005)FoodMicrobiology,1<sup>st</sup> Ed., New Age International(P)Ltd., New Delhi.
4. Ragesh Bhatia (2000),Quality assurance in Microbiology

**Web sources:**

1. <https://ncert.nic.in/textbook/pdf/lehe105.pdf>
2. [https://onlinecourses.swayam2.ac.in/cec20\\_ag06/preview](https://onlinecourses.swayam2.ac.in/cec20_ag06/preview)
3. <https://www.ficsi.in/blog/ensuring-excellence-the-crucial-role-of-quality-control-in-the-food-industry/>
4. <https://adamasuniversity.ac.in/food-safety-quality-control-microbiological-aspects-scopes/>
5. [https://www.fssai.gov.in/upload/media/FSSAI\\_News\\_quality\\_FNB\\_17\\_09\\_2019.pdf](https://www.fssai.gov.in/upload/media/FSSAI_News_quality_FNB_17_09_2019.pdf)



# SEMESTER IV

## **RESEARCH METHODOLOGY AND BIostatISTICS**

### **Course Objectives:**

- To understand fundamental statistical concepts and their relevance in biomedical research.
- To learn about different types of study designs and their strengths and limitations.
- To acquire skills in data collection, management, and quality assurance.
- To gain proficiency in using statistical software for data analysis.
- To interpret statistical results and communicate findings effectively.

### **Course Outcome:**

<b>CO1</b>	Discuss the methods and techniques of data collection.
<b>CO2</b>	Explain sampling methods, write research reports and articles.
<b>CO3</b>	Discuss the basic concepts of Biostatistics.
<b>CO4</b>	Explain the tests of significance.
<b>CO5</b>	Describe statistical software for analysis.

### **UNIT - I**

**No. of Hours: 12**

**Introduction to Research Methodology** - Meaning and importance. Statement, Constraints. Review of literature - Review and synopsis presentation. Types of research, Research tools. Methods and techniques of data collection - types of data, methods of primary data collection (observation/ experimentation/ questionnaire/ interviewing/ case/pilot study, methods), methods of secondary data collection.

### **UNIT - II**

**No. of Hours: 12**

**Sampling and sampling distributions.** Sampling frame, importance of probability sampling, sampling - simple random, systematic, stratified random and cluster. Variables - nominal, ordinal, discontinuous, continuous, derived. Research process, designs and Report writing - types of research reports, guidelines for writing an article and report, report format, appendices, Ethical issues related to publishing, Plagiarism and Self-Plagiarism H-Index, Publications in indexed Journals (Scopus, UGC CARE, and Web of Science).

### **UNIT – III**

**No. of Hours: 12**

**Introduction to Biostatistics** - Basic concepts, Measurement and measurement scales, Sampling and data collection, Data presentation. Measures of central tendency: Mean, Median, Mode. Measures of variability - Standard deviation, standard error, range, mean deviation and coefficient of variation. Frequency table of single discrete variable, bubble plot, computation of mean, variance and standard Deviations, t test, correlation coefficient.

### **UNIT - IV**

**No. of Hours: 12**

**Correlation and regression** - Positive, negative, calculation of Karl-Pearsons co-efficient of correlation. Linear regression and multiple linear regression, ANOVA, one and two way classification. Calculation of an unknown variable using regression equation. Tests of significance - Tests of significance: Small sample test (Chi-square t test, F test), large sample test (Z test) and standard error.

### **UNIT - V**

**No. of Hours: 12**

**Probability and distributions** - Introduction to probability theory and distributions, (concept without deviation) binomial, poisson and normal (only definitions and problems) Computer oriented statistical techniques. RSM: methods for process optimization set up CCD, Box Behnken, optimal RSM design, regression models FDS curves, surface contours, multi linear constraints and categoric factors to optimal design.

### **Text Books**

1. Sharma K. R. (2002) Research methodology. National Publishing House, New Delhi.
2. Daniel W.W. (2005). Biostatistics; A foundation for analysis in the health sciences. (7th Edition). Jhon Wiley & sons Inc, New York.
3. Rao P. S. S. and Richard J. (2006). Introduction to Biostatistics & Research methods. Prentice-Hall, New Delhi.
4. Veerakumari L. (2015) Bio instrumentation 1st edn. MJP Publishers.
5. Ahuja V.K. (2017) Laws Relating to Intellectual Property Rights. Lexis Nexis.

### **References Books**

1. Zar J. H. (2006). Biostatistical Analysis. (4th Edition). Pearson Education Inc. New Jersey.
2. Beins B. C. and McCarthy M.A. (2011). Research Methods and Statistics. Pearson Education Inc. New Jersey.
3. Adams K. A. and Lawrence E. M. K. (2014). Research Methods, Statistics, and Applications. SAGE Publications, Inc., New Delhi.
4. Anderson J.B. and Poole M. (2011). Assignment and Thesis Writing. 4th edn. Wiley India Private Limited.

5. Kothari C.R. and Garg G (2004) Research Methodology: Methods and Techniques. 2nd Edition. New Age International Publishers

### **Web Sources**

1. <https://www.studocu.com/en-ca/document/mount-royal-university/quantitative-research-methods-and-data-analysis/lecture-notes-all-lectures/344093><https://www.khanacademy.org/math/statistics-probability/sampling-distributions-library>  
<https://testbook.com/learn/maths-mean-median-mode>
2. <https://rcub.ac.in/econtent/ug/bcom/sem4/Business%20Statistics%20Unit%204%20Correlation%20and%20Regression.pdf>

## **MEDICAL LABORATORY TECHNOLOGY**

### **Course Objectives**

- Understand the fundamental concepts of laboratory.
- Comprehend the procedure on inoculation and preservation methods.
- Acquire knowledge about the blood composition and grouping.
- Gain knowledge on collection and examination of clinical specimens.
- Understand the antibody - antigen reactions and blotting techniques.

### **Course Outcome:**

<b>CO1</b>	Understand and analyze the basic lab principles and procedures
<b>CO2</b>	Apply the knowledge on identification of microorganism by staining
<b>CO3</b>	Know how to perform blood grouping and complete blood count
<b>CO4</b>	Gain information about test collection and examination of clinical specimens and perform antibiotic sensitivity test.
<b>CO5</b>	Acquire the knowledge to differentiate the antigen-antibody reactions and blotting techniques

### **UNIT - I**

**No. of Hours:06**

Basic lab principles and procedures - lab accidents – causes and prevention- lab safety rules and regulations - Preparation of glasswares - Sterilization - principles and methods - quality control in sterilization

### **UNIT - II**

**No. of Hours:06**

Inoculation methods and preservation of cultures - Staining techniques and methods – Simple, Differential and Special staining- Gram's staining, AFB staining, Capsular, Endospore and Metachromatic staining - Identification of bacteria by biochemical test- Lab methods of diagnosing fungal infections - KOH and LCB mount.

### **UNIT - III**

**No. of Hours:06**

Introduction - Blood composition - Anticoagulant - Complete Blood Count - ABO Blood grouping & Rh typing - Rh type incompatibility - Transfusion reaction.

### **UNIT - I**

**No. of Hours:06**

Collection and Examination of Clinical specimens - Urine, Blood, Faeces, CSF - Concentration techniques in stool - Examination of blood for malaria -.Antibiotic Sensitivity test- Microdilution, Kirby bauer and Stokes diffusion method.

### **UNIT - I**

**No. of Hours:06**

Antigen-Antibody reaction – General features and types - Precipitation, Immunoelectrophoresis  
Immunofluorescence - RIA, ELISA, Agglutination-Direct and Indirect - Immunoblotting technique -  
Western blot.

### **Text Books**

1. Mukerjee KL and Ghosh S (2010). Medical Laboratory Technology: Procedure Manual for Routine Diagnostic Tests. Volume 1. 2<sup>nd</sup> Edition. Tata McGraw Hill Education Pvt Ltd., New Delhi.
2. Chakraborty P (2015). A Text Book of Microbiology. 2<sup>nd</sup> Edition, Published by New Central Book Agency (P) Ltd., Kolkata.
3. Dubey RC and Maheswari DK (2013). A Text Book of Microbiology, 3<sup>rd</sup> Edition. S. Chand Publishing, New Delhi.

### **Reference Books**

1. Arti Kapil (2013). Ananthanarayan and Paniker's Text Book of Microbiology, 9<sup>th</sup> Edition, Orient Blackswan Private Limited.
2. Godkar PB and Godkar DP (2008). Text Book of Medical Laboratory Technology, 2<sup>nd</sup> Edition, Bhalani Publishing House, New Delhi.
3. Cheesbrough M (2006). District Laboratory Practice in Tropical Countries, Part 1 & 2. 2<sup>nd</sup> Edition, Cambridge University Press, Cambridge.

### **Web Sources**

1. <https://bio.libretexts.org/>
2. <https://www.biologydiscussion.com/>
3. <https://www.britannica.com/>
4. <https://www.labcorp.com/>
5. <https://microbenotes.com/>