M.SC APPLIED MICROBIOLOGY

CURRICULUM AND SYLLABUS-CBCS

(with effect from 2022-2023 onwards)

DEPARTMENT OF MICROBIOLOGY

Self-financed stream

Madras Christian College (Autonomous)

East Tambaram, Chennai

M.Sc. Applied Microbiology

Curriculum 2022-2023 - CBCS

Program-specific Outcomes for M.Sc. Applied Microbiology

Students of M.Sc. Applied Microbiology will be able to

PSO. No	Program Specific Outcomes
PSO-1	Acquire knowledge of fundamental and advanced concepts of Microbiology in general, and domain-related requirements of various disciplines of Applied Microbiology.
PSO-2	Associate the microbiological knowledge acquired towards research, innovation, and entrepreneurship for diverse global professional opportunities.
PSO-3	Administer microbiological analytical skills in clinical diagnosis and in public health sectors.
PSO-4	Infer and associate laboratory skills with real-life professional and social problems and appraise the significance and ethics involved of the methodologies used.
PSO-5	Assess their domain-specific digital and scientific communication skills for use in professional practice.
PSO-6	Integrate self-directed learning skills to adapt to the requirements and changing needs of the specific industrial sector.

Mapping of PSO's with PO's for M.Sc. Applied Microbiology

On completion of M.Sc. Applied Microbiology program the students will be able to

PSO No.	Statement	Matching PO	CL
PSO1	Acquire knowledge of fundamental and advanced concepts of Microbiology in general, and domain-related requirements of various disciplines of Applied Microbiology.	PO1: • Develop intensive and extensive knowledge and expertise in their respective domains • Evaluate and create/construct domain specific knowledge in areas of learning, research, and industry • Formulate and extrapolate the knowledge gained to apply in real – life situations and competitive examinations PO2: • Apply advanced knowledge and approaches to solve concrete and abstract problems in domain-related and multi-disciplinary issues.	R, U & Ap
PSO2	Associate the microbiological knowledge acquired towards research, innovation, pand entrepreneurship for diverse global professional opportunities.	PO3: • Develop aptitude for innovation and entrepreneurship • Identify contemporary research problems, analyze data and propose solutions PO7: • Choose from diverse career options available in local, national and international realms. • Carry out further research or pursue higher education in the country or abroad	Ap, An & C
PSO3	Administer microbiological analytical skills in clinical diagnosis and in public health sectors.	PO2: • Translate theoretical understanding to experimental knowledge and solve complex problems using Systems/Design Thinking • Apply advanced knowledge and approaches to solve concrete and abstract problems in domain-related and multi-disciplinary issues. • Able to solve problems using unconventional and creative approaches.	Ap, An & E
PSO4	Infer and associate laboratory skills with real-life professional and social problems and appraise the significance and ethics involved of the methodologies used.	PO6: • Apply domain specific ethical principles and practices in academic, professional and social engagements	Ap, An & E

PSO5	Assess their domain-specific digital and scientific communication skills for use in professional practice.	PO4: • Document, prepare and present scientific work as reports and research articles in academic forums • Critically assess, review and present theories, principles and concepts PO5: • Use of domain-related advanced software resources, computational skills anddigital tools for data analysis, visualization and interpretation • Ethically apply digital skills to creatively communicate a wide range of ideas and issues related to academic experiences	Ap, An & E
PSO6	Integrate self-directed learning skills to adapt to the requirements and changing needs of the specific industrial sector	PO1: • Develop an aptitude for self-directed learning for excellence in their chosen area within the domain of study	Ap, An, E& C

STRUCTURE OF CBCS FOR M.Sc. APPLIED MICROBIOLOGY (SFS) 2022-2023 ONWARDS					
SEMESTER I					
Paper No	**Component**	**Course**	**Hours**	**Credits**	**Weighted Marks ICA + ESE***
C-1	Major Core-1	Fundamentals of Microbiology	6	5	50+50
C-2	Major Core-2	Immunology and Immunotechnology	6	5	50+50
E-1	Elective-1	Microbial Physiology/ Analytical techniques in Biology	6	5	50+50
P-1	Core Practical -I	Fundamentals of Microbiology (Practical)	6	3	50+50
		Immunology and Immunotechnology (Practical)	6	3	50+50
	Core theory + Practical		24	16	
	Elective		6	5	
	Sub Total		30	21	

SEMESTER II					
Paper No	Component	Course	Hours	Credits	Weighted Marks ICA + ESE*
C-3	Major Core-3	Bacteriology & Parasitology (Theory)	6	5	50+50
C-4	Major Core-4	Soil, Agricultural and Environmental Microbiology (Theory)	6	5	50+50
E-2	Elective-2	Research Methodology and Biostatistics/ Computer Application and Bioinformatics	6	5	50+50
SS-1		Soft Skills-I	2	4	50
		Internship**	-	2	-
P-2	Core Practical- II	Bacteriology & Parasitology (Practical)	5	3	50+50
		Soil, Agricultural and Environmental Microbiology (Practical)	5	3	50+50
Core theory + Practical			22	16	
Elective			6	5	
Soft skills			2	4	
Internship**			-	2	
Sub Total			30	27	

**Includes students' presentations on their internship experience.

SEMESTER III					
Paper No	Component	Course	Hours	Credits	Weighted Marks ICA + ESE*
C-5	Major Core-5	Microbial Genetics, Molecular Biology and rDNA technology (Theory)	6	5	50+50
C-6	Major Core-6	Food, Dairy and Pharmaceutical Microbiology (Theory)	6	5	50+50
E-3	Elective-3	Health Research, Pharmacovigilance and Pharmaceutical Regulatory Affairs /Entrepreneurship in Microbiology	6	5	50+50
SS-II		Soft Skills-II	2	4	50
P-3	Core Practical-III	Microbial Genetics, Molecular Biology and rDNA technology (Practical)	5	3	50+50
		Food, Dairy and Pharmaceutical Microbiology (Practical)	5	3	50+50
Core theory + Practical			22	16	
Soft skills			2	4	
Elective			6	5	
Sub Total			30	25	

SEMESTER IV					
Paper No	Component	Course	Hours	Credits	Weighted Marks ICA + ESE*
C-7	Major Core-7	Virology and Mycology (Theory)	6	5	50+50
C-8	Major Core-8	Microbial Technology and IPR(Theory)	5	5	50+50
E-4	Elective-4	Nanobiotechnology/ Microalgal Biotechnology	4	5	50+50
P-4	Core Practical-IV	Virology and Mycology (Practical)	4	3	50+50
		Microbial Technology and IPR(Practical)	4	3	50+50
Pr-1	Project work		7	6	50+50
Core + Practical + Project work			26	22	
Elective			4	5	
Sub Total			30	27	

ESE* is conducted for 100 marks and converted to 50 marks

Semesters	I	II	III	IV	Total
Instructional Hours	30	30	30	30	120
Credits	21	27	25	27	100

Number of credits

Major-core theory and practical	64
Elective	20
Soft Skills	8
Internship	2
Project	6
Total	100

Syllabus Revision Details
(Nomenclature changed for one course)

Course Title	Revised/Renamed/Replaced	% of change
Semester I		
Fundamentals of Microbiology	Revised	10
Immunology and Immunotechnology	Revised	20
Microbial Physiology	Revised	10
Analytical techniques in Biology	Revised	5
Fundamentals of Microbiology (Practical)	Revised	10
Immunology and Immunotechnology (Practical)	Revised	10
Semester II		
Bacteriology & Parasitology (Theory)	Revised	20
Soil, Agricultural and Environmental Microbiology (Theory)	Revised	5
Research Methodology and Biostatistics	Revised	40
Computer Application and Bioinformatics	Revised	10
Bacteriology & Parasitology (Practical)	Revised	10
Soil, Agricultural and Environmental Microbiology (Practical)	Revised	5
Semester III		
Microbial Genetics, Molecular Biology and rDNA technology (Theory)	Revised	10
Food, Dairy and Pharmaceutical Microbiology (Theory)	Revised	10
Health Research, Pharmacovigilance and Pharmaceutical Regulatory Affairs (Previous nomenclature: Health Research and Pharmacovigilance)	Revised and Renamed	40

Entrepreneurship in Microbiology	Revised	50
Microbial Genetics, Molecular Biology and rDNA technology (Practical)	Revised	5
Food, Dairy and Pharmaceutical Microbiology (Practical)	Revised	5
Semester IV		
Virology and Mycology (Theory)	Revised	5
Microbial Technology and IPR (Theory)	Revised	5
Nanobiotechnology (Theory)	Revised	5
Microalgal Biotechnology (Theory)	Revised	10
Virology and Mycology (Practical)	Retained	-
Microbial Technology and IPR (Practical)	Revised	5

Evaluation pattern for Internal Continuous Assessment (ICA)

S. No.	Component	Duration	Max Marks	Nature of the Test
1	CA I	2 hours	50	Written
2	CA II	-	50	Any innovative task
3	CA III	2 hours	50	Written

Evaluation pattern for End Semester examination (100 marks)

Question Paper pattern

Section A 10 x 2 = 20 marks (All questions are compulsory)

Section B 4 x 10 = 40 marks (4 of 6 questions)

Section C 2 x 20 = 40 marks (‘Either-or’ type questions)

Evaluation of Project Work (IV Semester)

Thesis content (Novelty & Relevance, Literature Survey, Methodology adopted, Presentation)	80 Marks
Viva-voce	20 Marks
Total	100 marks

Requirement for qualifying for M.Sc. degree in Microbiology

The student must secure overall 100 credits.

Semester I – Core Paper
Fundamentals of Microbiology

(Candidates admitted from the academic year 2022 – 2023)

Total Hours: 78 **Credits: 5**

Learning Objectives	
(i)	To introduce the contribution of pioneers in the field of Microbiology and the fundamental structures of microorganisms
(ii)	To illustrate the taxonomy and the classification of microorganisms
(iii)	To impart the knowledge on microscopy, staining and sterilization procedures.
(iv)	To learn the cultivation of microorganisms, its preservation and the biosafety levels of lab.
(v)	To study multidrug resistance in organisms, its management and handling of lab animals.

CO No.	Course Outcome Upon completion of this course, students will be able to	PSOs Addressed	CL
CO1	Define the concepts and fundamental principles of microbiology	PSO 1	R, U
CO2	Describe the diversity of microorganisms	PSO1, PSO 2	R, U
CO3	Demonstrate the principles, working, and applications of various microscopes	PSO1, PSO 3, PSO 4	R, U, An
CO4	Differentiate microorganisms based on conventional and molecular methods	PSO 1, PSO 3, PSO 4	Ap, An
CO5	Recommend biosafety levels in microbiology laboratory	PSO 2, PSO 4, PSO 6	An
CO6	Elaborate on mechanisms of antimicrobial resistance	PSO 2, PSO 3 & PSO 4	Ap, An

Unit – I **Hours: 12**

Introduction, History and Evolution of Microbiology; Contributions of AntonVan Leeuwenhoek, Joseph Lister, Pasteur, Koch, Jenner, Winogradsky, Beijerinck; Impact of microbes on human welfare. Structure of Prokaryotic and Eukaryotic cell. Differences between Eubacteria, Archaebacteria and Eukaryotes.

Unit – II **Hours: 18**

Identification, characterization and classification of microorganisms; outline of Bergey's system of classification, Hackel's three kingdom concept, Whittaker's five kingdom concept, six and eight kingdom concepts, three domain concepts of Carl Woese. Major characteristics used in Taxonomy: Phenotypic characters, Biochemical tests (e.g., API, BIOLOG), numerical taxonomy, Chemotaxonomic markers, protein profiles, Nucleic acid-based techniques; 16S rRNA gene sequencing.

Unit – III **Hours: 15**

Microscopy - its principle and applications – simple, compound, Bright field, Dark field, Phase contrast, Fluorescence microscopy, transmission and scanning electron microscopy, STEM, Specimen preparation for electron microscopy. Live cell imaging, Confocal Microscopy, Two-photon microscopy, Polarized Microscopy, Atomic Force Microscopy, Differential interference Contrast Microscope.

Unit – IV **Hours: 18**

Microbial cultures: Concepts of pure culture. Cell division and cell cycle, Methods of Pure culture isolation, Enrichment culturing techniques, single cell isolation by Micromanipulator technique. Preservation and maintenance of microbial cultures. Staining techniques – Simple and differential staining, special staining – Acid fast staining, Capsule staining, Flagellar staining, Endospore staining.

Unit – V **Hours: 15**

Microbiological media – Natural and synthetic, basal, defined complex, enrichment, selective, differential, maintenance and transport media. Control of Microorganisms: Physical and Chemical methods, Filtration and Radiation methods. Biosafety in Microbiology – common laboratory contaminants, potentially hazardous procedures, Risk Assessment, Restricted access, Biological Safety Level (BSL). Antibiotics – Types and Modes of action, mechanisms of resistance by microorganisms – emergence of multidrug resistance and its management.

Text Books:

1.Lansing M Prescott, Donald A Klein, John P Harley. (2017). Microbiology. 10th edition.McGraw-Hill.Inc., US.
2.Gerard J Tortora, Berdell R Funke, Christine L Case. (2015). Microbiology: An Introduction.12th Edition, Dorling Kindersley (India) Pvt Ltd.,
3.Michael J Pelczar *et al.* (2009). Microbiology: Application Based Approach. McGraw- Hill. Inc., US.
4.Roger Y Stanier, John L Ingraham, Mark L Wheelis. (1999).General Microbiology.5th Edition(International Edition).Palgrave Macmillan.

Suggested Readings

1.R.C. Dubey and O.K.Maheswari S. (2003). A textbook of microbiology
2.Madigan Michael T. Martinko John M. Bender Kelly S. (2017) - Brock Biology of Microorganisms
3.Ananthanarayan and Paniker. (2017). Textbook of Microbiology Tenth edition

References

1. Ronald M. Atlas. (1997). Principles of Microbiology.2nd Edition.Dubuque, IA: Wm. C. Brown Publishers.
2. Jacquelyn Black. (2017). Microbiology: Principles and Explorations.10th Edition,Wiley Publishers.
3. A J Salle. (2007). Fundamental Principles of Bacteriology.Envins Press
4. Power and Daginawala. (2012). General Microbiology.Vol-I, Himalaya Publishing House.
5. Power and Daginawala. (2017). General Microbiology.Vol-II,Himalaya Publishing House.
6. Kathleen Park Talaro, 9th Edition (2014). Foundations in Microbiology McGraw Hill. Science.
7. Stuart Walker. (2003). Microbiology. W B Saunders Company.

Online Resources:

1.http://www.mmc.gov.bd/downloadable%20file/Introduction&%20history%20of%20mihttp://www.mmc.gov.bd/downloadable file/Introduction%26 history of microbiology for fb.pdf1crobiology%20for%20fb.pdf1.
2.http://light.ece.illinois.edu/ECE460/PDF/Chap%20XVIII%20-%20Microscopy_a.pdf
3.https://microbeonline.com/types-of-bacteriological-culture-medium/
4.https://www.thepharmaeducation.com/2020/07/sterilization-techniques-different-methods-of-sterilization.html
5.https://open.oregonstate.education/generalmicrobiology/chapter/microbial-growth/

Semester I – Core Practical
Fundamentals of Microbiology

(Candidates admitted from the academic year 2022 – 2023)

Total Hours: 78 **Credits: 3**

Learning Objectives	
(i)	To demonstrate the microbial diversity in hay-infusion broth and motility of bacteria.
(ii)	To get familiarized with staining techniques and motility by dark and phase contrast microscope.
(iii)	To learn the preparation of different types of media and plating techniques.
(iv)	To identify the structure of fungi and algae by staining and wet mount method.
(v)	To understand the growth curve by turbidometry and identification by micrometry and biochemical test

CO No.	**Course Outcome** Upon completion of this course, students will be able to	**PSOs Addressed**	**CL**
CO1	Describe the diversity of microorganisms, its structure and motility	PSO 1	U
CO2	Discuss the concepts of microscopy and staining techniques	PSO 1, PSO 3& PSO 4	R, Ap
CO3	Experiment with the plating technique and preparation of various types of media	PSO 2, PSO 3 & PSO 4	Ap, An
CO4	Appraise the structure of fungi and algae by respective methods	PSO 1, PSO 3	U, An
CO5	Measure the growth curve of bacteria by turbidometry	PSO 1 & PSO 2	An, E
CO6	Prepare suitable growth media for cultivation of microorganisms	PSO 1, PSO 2& PSO 3	Ap, E

1. Determination of microbial diversity by Hay-infusion broth.
2. Demonstration of motility of bacteria by hanging drop experiment
3. Demonstration of motility by dark field and phase contrast microscope.
4. Staining methods- Gram staining, acid fast staining, negative staining for capsules, metachromatic granular staining, spore staining, nucleic acid staining.
5. Preparation of solid, liquid and semisolid media.
6. Preparation of Enriched and Transport media.
7. Streak plate techniques, pour plate techniques, spread plate techniques, stab culture.

8. Lactophenol cotton blue-staining of fungi.
9. Demonstration of algae by wet mount.
10. Determination of bacterial growth curve by turbidometry and cell count (viable and microscopic) methods.
11. Preparation of various biochemical media and demonstration of growth in various bacteria.
12. Micrometry

Text Books:

1.Amita Jain, Vimala Venkatesh, Jyotsna Agarwal. (2019). Microbiology Practical Manual, First edition, Elsevier -Saunders, Mosby, Churchill.
2.Gunasekaran. (2018). Laboratory Manual in Microbiology, Second edition, New Age International (P) Ltd Publishers.

References:

1. R.C. Dubey, D.K. Maheshwari and S. Chand (2012). Practical Microbiology. Publisher: S. Chand Publications
2. R. Saravanan, D. Dhachinamoorthi.A and CH.MM. Prasada Rao. (2019). Handbook of Practical Microbiology, Publisher: Lambert Academic Publishing.
3. Emanuel Goldman and Lorrence H Green. (2021). Practical Handbook of Microbiology, 4th edition, Publisher: CRC Press.

Online Resources:

1.https://bio.libretexts.org/Learning_Objects/Laboratory_Experiments/Microbiology_Labs/Book%3A_General_Microbiology_Lab_Manual_(Pakpour_and_Horgan)
2.https://microbiologysociety.org/publication/education-outreach-resources/basic-practical-microbiology-a-manual.html
3.https://www.researchgate.net/publication/257380059_Laboratory_Manual_in_General_Microbiology_For_Undergraduate_Students_Short_Version

Semester I – Core Paper
Immunology and Immunotechnology

(Candidates admitted from the academic year 2022 – 2023)

Total Hours: 78 **Credits: 5**

Learning Objectives	
(i)	To enable the students to understand the fundamental principles of immunology.
(ii)	To learn about the role of the immune system in the elimination of pathogens.
(iii)	Acquire knowledge on adverse effects of our immune system.
(iv)	To study about the various types of vaccines and its development.
(v)	To learn about various immuno diagnostic techniques.

CO No.	**Course Outcome** Upon completion of this course, students will be able to	**PSOs Addressed**	**CL**
CO1	Recall the basic concepts of the human immune system	PSO 1, PSO 2	R, U
CO2	Associate the use of animal models in immunological studies	PSO2, PSO 3 & PSO 4	U, Ap
CO3	Develop knowledge about antigen processing, presentation and elimination	PSO 1, PSO 2 & PSO4	R, An
CO4	Explain the adverse effects of immune system.	PSO 2, PSO 3, PSO 4 & PSO 6	U, An
CO5	Choose appropriate prophylactic methods	PSO 2, PSO 3, PSO 4 & PSO 6	An, E
CO6	Elaborate on various immunodiagnostic techniques	PSO 2, PSO 3, PSO 4 & PSO 6	Ap, E

Unit I **Hours: 18**

Introduction to immunity. Types of immunity – innate and adaptive. Lymphoid reticular system: Structure and function of the cells and organs of the immune system. Phagocytosis and extracellular killing. Gnotobiotic animals: nude mouse, knock-out mouse. Germfree animals.

Unit II **Hours: 15**

Antigens and their properties. Immunoglobulins: Structure, types and functions. Major Histocompatibility complex [MHC]: types and properties. Antibody synthesis and diversity. Monoclonal antibody production. Complement system – classical and alternate pathways. Immunomodulators: cytokines, interleukins. Acquired immune response – Humoral and cell-mediated immune response.

Unit III **Hours: 18**

Immunodeficiency disorders. Hypersensitivity: Immediate and Delayed. Autoimmune disorders. Cancer immunology: tumor antigen, immune response to tumor, cancer immunotherapy. Transplantation immunology: Immunological basis of graft rejection. Effect of stress in immune function.

Unit IV **Hours: 15**

Preparation of bacterial, viral and fungal antigens. Prophylaxis: vaccines – live, killed, attenuated, Recombinant DNA vaccine, synthetic peptide vaccine and DNA vaccine. Passive immunization – antitoxins, raising of polyclonal antiserum. Immunization schedule.

Unit V **Hours: 12**

Immunotechnology and its applications – Antigen-antibody reactions: precipitation, agglutination, complement fixation test, immunochromatography techniques, radiology in immune diagnosis. Enzyme-linked immunosorbent assay [ELISA], Western blotting, Flow cytometry and Immune electron microscopy. Recent immunological diagnostic techniques for allergy.

Text Books:

1.R.A. Goldsby, T.J. Kindt and B.A. Osborne. (2020). Kuby Immunology. W.H. Freeman and Company, New York.
2.Ivan M. Roitt and Peter J. Delves. (2017). Essential Immunology, Blackwell Science Ltd. Oxford.
3. Abul Abbas Andrew H. Lichtman, Shiv Pillai. (2021). Cellular and Molecular immunology, 10th edition Elsevier.

Suggested Reading:

1.Ananthanarayan &Paniker. (2017). Textbook of Microbiology, Orient Blackswan Publisher.
2.Peter Parham. (2014). The immune system, 4th edition, Garland Science Publisher.

References:

1.C.A. Janeway, P. Travers, M. Walport and M.J. Shlomchik. (2001). Immunobiology: The Immune System in Health and Disease. Garland Publishing, USA.
2.Stefan E. Kaufmann, Alan Sher and Rafi Ahmed. (2002). Immunology of Infectious diseases, ASM Press, USA.
3.Peter Wood. (2001). Understanding Immunology, University of Manchester, Pearson Education Lts, Essex.
4.Maurice R.G. O'Gorman, Albert D. Donnenberg, 2nd edition (2008) Handbook of Human Immunology, C.R.C Press.
5.Noel R. Rose, Chief Editor: Robert G. Hamilton and Barbara Detric k (Eds.) (2002). Manual of Clinical Laboratory and Immunology 6th Edition. ASM Publications.

Online Resources:

1.Harvard Medical School: Learn Immunology Online
https://onlinelearning.hms.harvard.edu/
2.ibiology: Immunology https://www.ibiology.org/

Semester I – Core Practical
Immunology and Immunotechnology

(Candidates admitted from the academic year 2022 – 2023)

Total Hours: 78 **Credits: 3**

Learning Objectives	
(i)	To train the students on immunodiagnosis of common diseases.
(ii)	To acquire skills on immunodiffusion techniques.
(iii)	To learn about electrophoretic methods in immunodiagnosis.
(iv)	To enable the student to learn about antigen preparation.
(v)	To learn about the detection of antigen and antibody through ELISA technique.

CO No.	**Course Outcome** Upon completion of this course, students will be able to	**PSOs Addressed**	**CL**
CO1	Examine about the various agglutination techniques in the diagnosis of common diseases.	PSO 1, PSO 2, PSO 3 & PSO 4	U,Ap
CO2	Associate the techniques involved in immunodiffusion tests.	PSO 2, PSO 3& PSO 4	Ap,An
CO3	Experiment with the electrophoretic methods used in immunology.	PSO 2, PSO 3 & PSO 4	U
CO4	Separate blood cells for immunological experiments	PSO 1, PSO 2, PSO 3 & PSO 4	U, An
CO5	Predict the morphology of peripheral blood cells.	PSO 1, PSO 3	U,An,
CO6	Formulate method for purification of immunoglobulin	PSO 2, PSO 3, PSO 4 & PSO 6	Ap,An

1. Preparation of bacterial antigen by homogenization.
2. Latex agglutination – RF, ASO and CRP.
3. Haemagglutination – Blood grouping and TPHA.
4. Immunodiffusion techniques – single radial, double immunodiffusion techniques.
5. Counter Immunoelectrophoresis.
6. ELISA –HbsAg.
7. Preparation of lymphocytes from peripheral blood by density gradient method.
8. Peripheral blood smear and differential staining.
9. Purification of immunoglobulin by ammonium sulphate precipitation method and SDS-PAGE analysis.
10. Immunochromatography: Demonstration

Textbooks:

1.Idris Adewale Ahmed (2018). Laboratory Manual - Basic Immunology Lincoln University Malaysia publishers.
2.Suhad Hadi Mohammed, Mohanad Mohsin Ahmed (2019). Practical Immunology. Lambert Academic publishers.

References:

1.Frank C. Hay, Olwyn M.R. Westwood. (2002). Practical Immunology, fourth edition, John Wiley & Sons, Inc.
2.G.P. Talwar & S.K. Gupta (2017). A Handbook of Practical and Clinical Immunology, volume II, CBS Publishers.

Online Resources:

1.https://www.inside-immunity.org/en.php
2.https://www.niaid.nih.gov/research/immune-system-disorders
3.https://webstor.srmist.edu.in/web_assets/downloads/2021/18BTC106J-lab-manual.pdf

Semester I – Elective Paper
Microbial Physiology

(Candidates admitted from the academic year 2022 – 2023)

Total Hours: 78 **Credits: 5**

Learning Objectives	
(i)	To understand the microbial mechanism of nutrient uptake and their growth kinetics
(ii)	To know about the catabolic processes and energy generation.
(iii)	Acquire knowledge about the biosynthesis of cellular macromolecules
(iv)	To get insights on anaerobic respiration, fermentation and methanogenesis
(v)	To learn about photosynthesis in phototrophic bacteria

CO No.	**Course Outcome** Upon completion of this course, students will be able to	**PSOs Addressed**	**CL**
CO1	Discover the microbial diversity based on nutritional requirements and their growth kinetics	PSO1	U, Ap
CO2	Explain microbial metabolic processes and their bioenergetics	PSO1, PSO2 & PSO3	U, An
CO3	Relate anaerobic respiration with energy yield	PSO1 & PSO2	U, An
CO4	Infer the processes of methanogenesis and fermentation.	PSO2, PSO4 & PSO6	Ap, An
CO5	Appraise the process of photophosphorylation in phototrophic bacteria	PSO1 & PSO2	U, Ap
CO6	Elaborate on the biosynthesis of biomolecules of the cell	PSO1 & PSO2	U, Ap

Unit -I **Hours: 18**

Classification of microorganisms based on nutritional requirements. Structure of cytoplasmic membrane and its significance in nutrient transport. Bacterial growth kinetics, measurement of generation time and specific growth rate. synchronous growth, continuous, batch, fed batch culture. Factors affecting microbial growth.

Unit-II **Hours: 18**

Introduction to bioenergetics. Microbial metabolism- Catabolism-Glycolysis, ED-Pathway, Gluconeogenesis, TCA Cycle, Glyoxylate cycle, HMP pathway, electron transport chain, structure and function of ATPase (bacterial), generation and maintenance of proton motive force, oxidative phosphorylation, inhibitors and un-couplers of electron transport chain and oxidative phosphorylation.

Unit-III **Hours: 15**

Anabolism- Amino acid biosynthesis, Biosynthesis of purine and pyrimidine bases-Salvage and De novo pathways. Biosynthesis of fatty acids and peptidoglycan. Catabolism – amino acids (Deamination, transamination and decarboxylation), beta oxidation of fatty acids.

Unit-IV **Hours: 15**

Anaerobic respiration- oxidized sulfur compounds, and nitrate as electron acceptor with respect to electron transport chain and energy generation, Biochemistry of methanogenesis, Fermentation-Homo/ heterolactic, mixed acid and alcohol.

Unit-V **Hours: 12**

Bacterial photosynthesis-oxygenic and anoxygenic photosynthesis-electron carriers, photosynthetic pigments, photophosphorylation in various groups of phototrophic bacteria, electron donors other than water in anoxygenic photosynthetic bacteria. Calvin cycle.

Text Books:

1. Albert G. Moat, John W. Foster, Michael P. Spector. (2002). Microbial Physiology. Wiley publishing.
2. Metzler David E. (2001). Biochemistry: The chemical reactions of Living Cells, Volume 1&2, Academic Press California.
3. S. Ram Reddy, S.M. Reddy (2008). Microbial Physiology. Anmol Publications Pvt Ltd.
4. S Meena Kumari (2006). Microbial Physiology publishers.

Suggested Reading:

1. David White, James Drummond, and Clay Fuqua. (2011). The Physiology and Biochemistry of Prokaryotes, 4th Edition, Oxford University Press.
2. Caldwell. D.R. (1995). Microbial Physiology and metabolism, Wm C. Brown Publishers.
3. Mariappan C. (2010). A textbook of general microbial physiology,
biochemistry and metabolism. Pooja Publishers, India.

References:

1. Nelson D. L. and Cox M. M. (2005). Lehninger's Principles of Biochemistry, Fourth edition, W. H. Freeman & Co. New York.
2. White David (2000) Physiology and Biochemistry of Prokaryotes. 2nd Ed. Oxford University Press, New York.
3. Robert K. Poole (2006). Advances in Microbial Physiology: Volume 51. Jaico Publishing house.
4. BhanuShrivastava. (2011). Microbial Physiology and Metabolism: Study of Microbial Physiology and Metabolism. Lambert academic Publication.

Online Resources:

1.https://onlinecourses.swayam2.ac.in/cec20_bt14/preview
2.http://web.iitd.ac.in/~amittal/2007_Addy_Enzymes_Chapter.pdf

Semester I – Elective Paper
Analytical Techniques in Biology

(Candidates admitted from the academic year 2022 – 2023)

Total Hours: 78 **Credits: 5**

Learning Objectives	
(i)	To learn about the principle, construction and working of the basic microbiological laboratory instruments.
(ii)	To know the principle and the applications of centrifuges, lyophiliser, sonication, microtomy and homogenizer
(iii)	To get knowledge on different spectroscopic techniques.
(iv)	To know about different chromatographic techniques
(v)	To study different electrophoretic techniques.

CO No.	**Course Outcome** Upon completion of this course, students will be able to	**PSOs Addressed**	**CL**
CO1	Acquire theoretical knowledge on the basic and modern laboratory instruments.	PSO 1, PSO 2	R, U
CO2	Explain the principles, instrumentation and working of centrifuge, electrophoresis and chromatography.	PSO 1, PSO2	U, Ap
CO3	Interpret the applications of various analytical techniques in the field of biology.	PSO 1, PSO 2, PSO 3 & PSO 4	Ap, E
CO4	Appreciate the significance of lab instruments in the industrial sector.	PSO 1, PSO 2& PSO 6	Ap, E
CO5	Apply various lab instruments in the field of research.	PSO 1, PSO 2 &PSO 4	U, Ap
CO6	Adapt a suitable analytical technique in characterization of biomolecules.	PSO 2, PSO 3 &PSO 6	E, C

Unit I **Hours: 12**

Basic Laboratory instruments: pH meter, Incubators and their types-bacteriological, BOD incubators, Co_2 incubators and anaerobic incubators, Water bath, Laminar air flow systems: Biosafety cabinets.

Unit II **Hours: 15**

Principle and applications of Centrifugation (preparative and analytical) – concept of g and rpm, svedberg unit, Types of centrifuges and rotors. Principles and applications of Lyophilization, Sonication, Desiccation/Vacuum Desiccation, Microtomy/ultramicrotomy, Homogenization.

Unit III **Hours: 18**

Spectroscopic Techniques: Principle, instrumentation, working and applications of UV-visible, IR, fluorescence spectrophotometry. Flame photometry, Mass and Nuclear Magnetic Resonance spectrometry. MALDI-TOFs. Radioisotopic Techniques: Uses of radioisotopes in biology, Geiger-Muller and scintillation counters, Flow cytometry and autoradiography.

Unit IV **Hours: 18**

Chromatography Techniques: Principle, instrumentation, working and applications of Chromatography - Paper Chromatography, TLC/HPTLC, Ion-Exchange chromatography, Affinity Chromatography, Gel permeation, GC, LC and HPLC – Reverse-phase chromatography

Unit V **Hours: 15**

Electrophoretic Techniques: Electrophoresis – Principle, instrumentation, working factors affecting electrophoresis - Paper Electrophoresis, Gel Electrophoresis: Agarose and PAGE (SDS-PAGE and Native PAGE), 2D Gel Electrophoresis**.**

Text Books:

1. L. Veerakumari. (2015). Bioinstrumentation. MJP Publisher
2. Webster. (2007). Bioinstrumentation. John Wiley and Sons.
3. M. H. Fulekar and Bhawana Pandey. (2013). Bioinstrumentation. I K International Publishing House Pvt. Ltd
4.K. K. Machve. (2007). A Textbook of Bioinstrumentation. Manglam Publications.

Suggested Reading:

1. MJ Reilly. (2016). Bioinstrumentation. CBS Publishers
2. M Prakash. (2009). Understanding Bioinstrumentation. Discovery Publishing House Pvt. Ltd.
3.Wilson K., Walker J. (2006). Principle and Techniques of Biochemistry and Molecular Biology. Cambridge University Press 6th edition.

References:

1. Meena Srivastava and Rajesh Singh Yadav. (2007). Principles of Laboratory Techniques and Methods.
2.Abhijit Paintal, Chinmoy Goswami and Rabindra Narain. (2011). Handbook of Bioinstrumentation. Dominant Publishers & Distributors.
3.Salmah B. Karman and S.Zaleha M. Diah. (2016). Principles and Techniques of Bioinstrumentation. Intelliz Press.

Online Resources:

1.https://www.pdfdrive.com/bioinstrumentation-tools-for-understanding-life-e50076411.html

Semester II – Core Paper
Bacteriology and Parasitology

(Candidates admitted from the academic year 2022 – 2023)

Total Hours: 78 **Credits: 5**

Learning Objectives	
(i)	To understand the pathogenesis of various kinds of bacteria.
(ii)	To describe the basic principle of collection and transport of clinical specimen in bacteriology.
(iii)	To acquire knowledge in diagnosis of various bacterial infections.
(iv)	To understand the lifecycle and pathogenesis of different parasitic infections.
(v)	To acquire knowledge on prevention and treatment of parasitic infections.

CO No.	**Course Outcome** Upon completion of this course, students will be able to	**PSOs Addressed**	**CL**
CO1	Acquire knowledge about bacterial diseases, pathogenesis and treatment.	PSO 1, PSO 2 & PSO3	R, U,
CO2	Discuss about the collection, transport, and processing of clinical samples.	PSO 2, PSO 3 & PSO 4	Ap, An
CO3	Choose relevant diagnostic procedures in bacteriology.	PSO 3, PSO 4	An
CO4	Explain medically important parasites.	PSO 1, PSO 2, PSO 3 & PSO 4	R, U
CO5	Recommend appropriate control and prevention methods of parasitic diseases.	PSO 3, PSO 4& PSO 6	E, C
CO6	Elaborate on maintenance of lab animals.	PSO 1, PSO 2, PSO 3 & PSO 4	Ap,An

Unit-I **Hours: 15**

Classification of medically important bacteria, normal flora of human body, collection and storage of clinical specimens, transport media, microbiological examination of clinical specimens, antimicrobial susceptibility testing. Handling and maintenance of laboratory animals – Rabbits, Guinea pigs and Mice.

Unit-II **Hours: 15**

Morphology, classification, characteristics, pathogenicity, laboratory diagnosis and treatment of diseases caused by *Staphylococci, Streptococci, Pneumococci, Neisseriae, Bacillus, Corynebacteria, Mycobacteria* & *Clostridium.*

Unit-III **Hours: 18**

Morphology, classification, characteristics, pathogenicity, laboratory diagnosis and treatment of diseases caused by *Enterobacteriaceae, Pseudomonads, Vibrios, Mycoplasma, Helicobacter (Helicobacter pylori), Rickettsiae*&*Spirochaetes.Yersinia, Bordetella, Francisella*.Nosocomial and opportunistic infection - prevention and control.

Unit-IV **Hours: 12**

Introduction and classification of parasites. Laboratory techniques in Parasitology. Intestinal amoebae – *Entamoeba histolytica*, Free living amoebae – *Naegleria fowleri*, *Acanthamoebae*sp. Intestinal and genital flagellates – *Giardia lamblia*, *Trichomonas vaginalis*.

Unit – V **Hours: 18**

Blood and tissue flagellates – *Leishmania donovani*, *Trypanosoma cruzi*&*Trypanosoma brucei complex.* Malarial parasites, *Toxoplasma gondii*, *Cryptosporidium* sp.Infection of helminthes – Cestodes – *Taenia saginata, Taenia solium*and *Echinococcus granulosus*. Trematodes - *Fasciola hepatica*, *Paragonimuswestermani* and *Schistosomes*. Nematodes – *Ascaris lumbricoides*, *Ancylostoma duodenale*, *Trichuris trichiura*, *Enterobius vermicularis* and *Wuchereriabancrofti*.

Text Books:

1. Tom Parker, M. Leslie H.Collier.(1990).Topley &Wilson's Principles of Bacteriology, Virology and Immunity (VIII Edition).London: Edward Arnold.
2. Greenwood, D., Slack, R.B. and Peutherer, J.F. (2012) Medical Microbiology, 18th Edn. Churchill Livingstone, London.
3. Finegold, S.M. (2000) Diagnostic Microbiology, 10th Edn. C.V. Mosby Company, St. Louis.
4. Ananthanarayanan, R. and Jayaram Panicker C.K. (2020). Textbook of Microbiology. Orient Longman, Hyderabad.

Suggested Reading:

1. A.J. Salle (2007). Fundamental principles of bacteriology, fourth edition, Tata McGraw-Hill Publications.
2. Larry Roberts, John Janovy, Jr. (2008), Foundations of Parasitology, eighth edition, McGraw-Hill Publications.

References:

1. Gerhardt, P., Murray, R.G., Wood, W.A. and Kreig, N.R. (Eds) (1994) Methods for General and Molecular Bacteriology. ASM Press, Washington, DC.
2. Subhash Chandra Parija. (2004). Textbook of Medical Parasitology – Protozoology and Helminthology. 2nd edition, published by All India Publishers and Distributors, Medical book publisher, New Delhi.
3. Karyakarte, R.P. and Damle, A.S. (2005). Medical Parasitology. Revised edition. Published by Books and Allied (P) Ltd., Kolkata.
4. Jeyaram Paniker. (2004). Textbook of Medical Parasitology. 5th edition, JAYPEE brothers, Medical Publishers (P) Ltd, New Delhi.
5. Ichpujani, R.L. and Rajesh Bhatia. (2003). Medical Parasitology. 3rd edition, JAYPEE brothers, medical publishers (P) Ltd, New Delhi.

Online Resources:

1. Todar's Online Textbook of Bacteriology http://textbookofbacteriology.net/
2. Centers for Disease Control and Prevention: Parasitology https://www.cdc.gov/parasites/

Semester II – Core Practical
Bacteriology and Parasitology

(Candidates admitted from the academic year 2022 – 2023)

Total Hours: 65 **Credits: 3**

Learning Objectives	
(i)	To learn about different staining techniques in the identification of bacteria.
(ii)	To acquire skill on isolation and identification of pathogenic bacteria by cultural and biochemical tests.
(iii)	To study antibacterial sensitivity methods.
(iv)	To understand the identification of parasites from stool samples.
(v)	To acquire knowledge on various staining methods in identification of parasites.

CO No.	**Course Outcome** Upon completion of this course, students will be able to	**PSOs Addressed**	**CL**
CO1	Acquire practical knowledge on different staining methods in identification of bacteria.	PSO 1	U, Ap
CO2	Identify the methods used in isolation of pathogenic bacteria using various media.	PSO 1, PSO 2, PSO 3& PSO 4	Ap, An
CO3	Demonstrate biochemical methods for identification of bacteria	PSO 1, PSO 2, PSO 3& PSO 4	Ap, An
CO4	Analyze antimicrobial sensitivity of bacteria.	PSO 2, PSO 3, PSO 4& PSO 6	An, E
CO5	Predict the methods used in examination of parasites.	PSO 1, PSO 2, PSO 3& PSO 4	Ap, An
CO6	Prepare blood smear for identification of parasites	PSO1, PSO 2, PSO 3 & PSO 4	U, Ap

1. Staining of clinical specimens - Wet mount, Differential and Special staining methods.
2. Isolation and identification of bacterial pathogens from clinical specimens - cultivation in basal, differential, enriched, selective and special media - Biochemical identification tests.
3. Enumeration of bacteria in urine to detect significant bacteriuria.
4. Antimicrobial sensitivity testing - Kirby bauer method and Stokes method.
5. Minimum inhibitory concentration (MIC) test.
6. Minimum bactericidal concentration (MBC) test.
7. Normal saline/Lugol's iodine preparation for the examination of parasites in stool.
8. Examination of faeces by concentration methods.
9. Thin and thick blood smears examination for malarial parasite

Text books:

1. D. Roy Cullimore. (2010). Practical Atlas for Bacterial Identification.2nd edition. Publisher-Taylor &Francis.
2. Alexander Crever Abbott. (2010). The Principles of Bacteriology. Nabu Press.
3. Chandrawathani, B.Premalatha,Jamnah Omar and Zaini Che Mamat (2019). Manual on Parasitology, published by Department of Veterinary services, Malaysia.

Reference Books:

1. Henrik Chart. (2018). Practical Laboratory Bacteriology. CRC Press.
2. Veranus A Moore, (2017) Laboratory Directions for Beginners in Bacteriology. Triste Publishing Ltd.
3. Chatterjee. (1986). Medical Parasitology. Tata McGraw Hill, New Delhi.

Online Resources:

1.Centers for Disease Control and Prevention: Parasitology
https://www.cdc.gov/parasites/
2.Todar's Online Textbook of Bacteriology: Bacteriology
http://textbookofbacteriology.net/

Semester II – Core Paper

Soil, Agricultural and Environmental Microbiology

(Candidates admitted from the academic year 2022 – 2023)

Total Hours: 78 **Credits: 5**

Learning Objectives	
(i)	To gain insights into soil, agricultural and environmental microbiology
(ii)	To understand the functioning of various wastewater treatment systems
(iii)	To know about the importance of biofertilizers and biopesticides
(iv)	To plan and perform microbiological analysis of environmental and wastewater samples
(v)	To learn about recent concepts including environmental management system

CO No.	**Course Outcome** Upon completion of this course, students will be able to	**PSOs Addressed**	**CL**
CO1	Acquire fundamental knowledge in soil microbial ecology and in-depth knowledge in environmental and agricultural microbiology	PSO1, PSO2	R, U
CO2	Understand the commercial and technical aspects of working of a wastewater treatment plant, and production of biofuels, biopesticides and biofertilizers, and understand the concepts of the environment management system	PSO1, PSO2, PSO4, PSO6	R, U, Ap
CO3	Plan appropriate experiments for microbiological analysis of environmental and wastewater samples.	PSO 2, PSO3, PSO4& PSO 6	Ap, An
CO4	Analyse and appreciate the advantages of environmental microbiology over other application domains.	PSO1, PSO 4 & PSO 6	U, An
CO5	Evaluate critically the cutting-edge technologies available in this domain	PSO1, PSO2, PSO 4 & PSO 6	An, E
CO6	Predict futuristic problems and create career/ pursue research in the field of environmental and agricultural microbiology	PSO2, PSO4, PSO5, PSO6	An,C

Unit – I **Hours: 18**

Soil as a habitat for microorganisms - Methods of studying microbial ecology of soils - Influence of environmental factors on soil microflora – Interactions between soil microorganisms – Interaction between microbes and plants: Rhizosphere, Phyllosphere, Mycorrhiza, Actinorhiza. Biogeochemical cycling – Carbon cycle – Organic matter decomposition and humus formation – Nitrogen cycling: Biological nitrogen fixation by diazotrophs; symbiotic and non-symbiotic

nitrogen fixation; Biochemistry of nitrogen fixation – Phosphorous, Sulphur, Iron and Manganese cycles.

Unit –II **Hours: 18**

Epidemiology of plant diseases – Pathology, aetiology and control of economically important crop diseases caused by bacteria (bacterial blight of paddy), fungi (downy mildew of grapes, red rot of sugarcane) and viruses (Tobacco mosaic). Microorganisms as biopesticides –*Bacillus thuringiensis*; integrated pest management. Microorganisms as biofertilizers – Bacterial biofertilizers: Rhizobium, Azospirillum, Azotobacter; cyanobacterial biofertilizers - Mass production and field application of biofertilizers.

Unit –III **Hours: 15**

Microbiology of air – Bioaerosols and Aero microbiological pathway – Air sampling devices and enumeration of microflora – Air-borne pathogens - Air sanitation and microbiological air standards. Microbiology of water – Water pollution and water-borne pathogens – Microbiological examination of water and indicator organisms – Sewage treatment: Primary, secondary and tertiary treatments; biological sludge treatment – Role of microorganisms in secondary treatment of industrial wastewaters.

Unit –IV **Hours: 15**

Concepts of waste to wealth – Applications of biosludge - biomethane; fertilizers/manure - Biofuels, their significance, prospects and sustainability – bioethanol, biodiesel and biocrude. Bioremediation and Biodegradation - Biodegradation of recalcitrant compounds: lignin, pesticides and plastics - Bio metallurgy – Negative role of microorganisms in environment: biodeterioration of paper, leather and monuments; biofouling and its prevention.

Unit –V **Hours: 12**

Extremophiles and their survival strategies - Environmental prospecting of potential microbes - Molecular techniques to assess microbial community structure, function and dynamics in the environment - Concept of metagenomics - Biological carbon sequestration - Carbon footprints, carbon credits and carbon trading – Concept of environmental economics - Environmental auditing: Environmental management system and ISO 14000.

Text Books:

1. Subba Rao N.S. (2017). Soil Microbiology (5th Edition), MedTech Publishers.
2. Rangaswami G & Mahadevan A. (2006). Diseases of Crop Plants in India (4th Edition), Prentice–Hall of India Pvt. Ltd.
3. Sharma P.D. (2010). Microbiology and Plant pathology (2nd edition). Rastogi Publications.
4.Barton L.L. & Northup D.E. (2011). Microbial Ecology,Wiley-Blackwell.

Suggested reading:

1. Robert L. Tate (2020). Soil Microbiology (3rd edition), Wiley Blackwell.
2. Ravichandra N.G. (2013). Fundamentals of Plant pathology. PHI Learning Pvt Ltd.
3. Willey J., Sandman K. & Wood D. (2020). Prescott's Microbiology (11th edition). McGraw-Hill Education.

References:

1. Pepper I.L., Gerba C.P. & Gentry T.J. (2014). Environmental Microbiology (3rd edition). Academic Press, Elsevier.
2. Bitton G. (2011). Wastewater Microbiology (4th edition). Wiley-Blackwell.
3. Bridgewater L. (2012). Standard Methods for the Examination of Water and Wastewater. American Public Health Association.
5. Shrivastava A.K. (2003). Environment Auditing. A.P.H. Publishing Corporation.
6. Tinsley S., & Pillai I. (2012). Environmental Management Systems – Understanding Organizational Drivers and Barriers. Earthscan.
7. Brohe A., Eyre N. &Howarth N. (2012). Carbon Markets – An International Business Guide. Earthscan.

Online resources:

1.https://nptel.ac.in/courses/126105016
2.https://www.classcentral.com/course/swayam-plant-pathology-and-soil-health-14236
3.https://nptel.ac.in/courses/102105087
4.https://archive.nptel.ac.in/noc/courses/noc19/SEM1/noc19-ce04/
5.https://archive.nptel.ac.in/noc/courses/noc22/SEM1/noc22-ge12/

Semester II – Core Practical

Soil, Agricultural and Environmental Microbiology

(Candidates admitted from the academic year 2022 – 2023)

Total Hours: 65 **Credits: 3**

Learning Objectives	
(i)	To reproduce the experimental skills learnt in the field of soil, agricultural and environmental microbiology
(ii)	To describe the experimental protocols related to studying microorganisms related to soil, in general, and agriculture in particular.
(iii)	To understand about air samplers and perform aeromicrobiological analysis
(iv)	To perform microbiological analysis of wastewater and treated wastewater samples
(v)	To relate the experimental results to the prescribed standards by the statutory bodies

CO No.	**Course Outcome** Upon completion of this course, students will be able to	**PSOs Addressed**	**CL**
CO1	Acquire experimental skills in soil, agricultural and environmental microbiology.	PSO1	R, U
CO2	Understand the nuances in environmental sample collection, transport and processing.	PSO1, PSO3, PSO4	U, Ap
CO3	Plan for appropriate experiments and apply the skill sets in analysing various environmental samples.	PSO3, PSO4	Ap
CO4	Appraise on the Pollution Control Board standards for treated wastes and BIS standards for water.	PSO1, PSO 3 & PSO 4	R
CO5	Compare the outcome of the experiments and relate it to prescribed standards.	PSO 2, PSO4, PSO6	An, E
CO6	Integrate the acquired experimental skills into research.	PSO2, PSO 4, PSO 6	R, Ap, C

1. Enumeration of microorganisms in air by settle plate, impingement and impaction methods.
2. Enumeration of microorganisms from soil/rhizosphere soil.
3. Isolation of free-living nitrogen fixers from soil and *Rhizobium* from root nodules of leguminous plants.
4. Isolation and enumeration of phosphate-solubilizing bacteria from soil.
5. Construction of the Winogradsky column for studying phototrophic soil bacteria.
6. Enumeration of microorganisms from phylloplane by leaf disc dilution and leaf impression methods.
7. Visual examination, observation, and identification of some common plant infections.

8. Isolation of plant pathogens: *Xanthomonas* from citrus canker leaf samples and *Erwinia* from infected carrots; fungal plant pathogens.
9. Microbiological analysis of water: Dilution method, membrane filtration method, determination of coliforms by presence–absence test and MPN method; detection of faecal coliforms in water by Eijkman test.
10. Estimation of 5-day BOD in a sewage sample.
11. Determination of MLSS/sludge settleability in activated sludge sample/TSS in sewage sample.

Text Books:

1. Aneja K.R. (2007). Experiments in Microbiology, Plant Pathology and Biotechnology (4th edition). New Age International.
2. Gunasekaran P. (2007). Laboratory Manual in Microbiology. New Age International.
3. Hurst, C.J., Crawford R.L., Garland J.L., Lipson D.A., Mills A.L., Stetzenbach L.D. (2007). Manual of Environmental Microbiology (3rd Edition). American Society for Microbiology.

References:

1. Pepper I., Gerba C., Brendecke J. (2004). Environmental Microbiology - A Laboratory Manual (2nd Edition). Academic Press, Elsevier.
2. Yates M.V., Nakatsu C.H., Miller R.V., Pillai, S.D. (2016). Manual of Environmental Microbiology (4th Edition). Wiley.

Online resources:

1.https://vlab.amrita.edu/index.php?sub=3&brch=272
2.https://nptel.ac.in/courses/102105087

Semester II – Elective

Research Methodology and Biostatistics

(Candidates admitted from the academic year 2022 – 2023)

Total Hours: 78 **Credits: 5**

Learning Objectives	
(i)	To explore insights into scientific research and to understand research designs and techniques.
(ii)	To learn the art of Scientific writing
(iii)	To imbibe research ethics in scientific research
(iv)	To apply various statistical methods for scientific research
(v)	To learn about statistical software to analyze and interpret the data.

CO No.	**Course Outcome** Upon completion of this course, students will be able to	**PSOs Addressed**	**CL**
CO1	Acquire knowledge of basic concepts of research methodology and apply statistical methods for research work	PSO-1, PSO-2& PSO 5	R, Ap
CO2	Understand the concepts of scientific writing, publication process and publication ethics.	PSO1, PSO-2& PSO-5	U,An
CO3	Apply the appropriate statistical method/tool required for a particular research design.	PSO-2&PSO-4	U, Ap
CO4	Categorize research articles based on research metrics.	PSO-1, PSO-2	U, An
CO5	Evaluate hypothesis testing using suitable statistical tests.	PSO-1, PSO-2, PSO-4	R, Ap
CO6	Choose a research problem and plan the research work based on extensive literature review.	PSO-1, PSO-2, PSO-4 PSO-5& PSO-6	Ap, C

Unit I **Hours: 12**

Importance and need for scientific research. Selection of a research problem. Designing of research work. Introduction to sampling methods – probability and non-probability sampling methods. Different types of controls. Setting up a hypothesis.

Unit II **Hours: 18**

Scientific writing: Dissertation and Thesis writing - review of literature. Publications: Types of articles − communications, full-length articles, reviews. Types of publications - open access, subscription and hybrid model. Manuscript preparation: format required for full-length articles − title, abstract, introduction, experimental methods and materials, results and discussions (IMRaD method), conclusions, references - various reference styles (Harvard and Vancouver systems) and reference management software, tables, figures, graphical abstracts and author guidelines. Process of peer review in journal publication. Components of a research proposal.

Unit III **Hours: 18**

Research ethics - ethics concerning science and research, research integrity, scientific misconduct - Falsification, Fabrication and Plagiarism (FFP) – types of plagiarism and plagiarism software. Publication ethics – Introduction and importance, best practices and guidelines – COPE. Violation of publication ethics - authorship and contributorship. Indexing database - web of science, Scopus and UGC care. Journal metrics - JCR impact factor, Cite Score, SNIP and SJR. Author and article metrics - h-index, i10 index, altmetrics. Predatory publishers and journals, cloned journals.

Unit IV **Hours: 15**

Statistics - Definitions, functions and applications in biological studies. Data - Types of data, methods of collection of primary and secondary data. Tabulation and diagrammatic presentation of data. Frequency distribution. Graphical representation – Histogram, frequency polygon, Ogive curves and Pie diagram. Correlation - Positive and negative correlation and Karl Pearson's Co-efficient of correlation. Linear and Multiple Regression equations. Estimation of an unknown variable using a regression equation.

Unit V **Hours: 15**

Measures of central tendency: mean, median and mode. Measures of Variation- Range, Quartile Deviation, Mean Deviation, Standard Deviation and standard error of mean. Hypothesis testing: levels of significance and levels of confidence - t-test; $\chi 2$ -test and F-test. Variance: Definition and significance; Analysis of variance (ANOVA). Computer based statistical tools (An introduction) – MS excel and SPSS.

Text Books:

1. Richard Colin Campbell, (2012). Statistics for Biologists, 3rd edition, University of Cambridge,
2. George W. Snedecor and William G. Cochran. (2014). Statistical Methods, Wiley India.
3. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K. (2002). An introduction to Research Methodology, RBSA Publishers.
4. Rosner, Bernard (2010). Studyguide for Fundamentals of Biostatistics. publisher: Cram101.

Suggested reading:

1. N. Gurumani. (2014). Research Methodology for Biological Sciences, MJP publishers.
2. Veer BalaRastogi. (2009). Fundamentals of Biostatistics, 2nd edition. ANE Books.
3. N. Gurumani. (2002). An Introduction to Biostatistics. MJP publishers.

References:

1. John W. Creswell and J. David Creswell. (2017). Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, 5th edition. SAGE publications.
2. Ajai S Gaur and Sanjaya S Gaur. (2009). Statistical Methods for Practice and Research: A Guide to Data Analysis Using SPSS, Sage Publications Pvt. Ltd.
3. Wolfgang Huber and Susan Holmes.(2019). Modern Statistics for Modern Biology, Cambridge University Press.

Online Resources:

1. https://nptel.ac.in/courses/102101056
2. https://onlinecourses.swayam2.ac.in/aic21_ge02/preview
3. https://swayam.gov.in/explorer?searchText=research%20methodology

Semester II – Elective
Computer Applications and Bioinformatics

(Candidates admitted from the academic year 2022 – 2023)

Total Hours: 78 **Credits: 5**

Learning Objectives	
(i)	To learn about the recent developments in computer technology
(ii)	To apply computer knowledge in biological science research
(iii)	To understand the programming languages in Bioinformatics
(iv)	To analyze and compare sequence alignment using bioinformatics tools
(v)	To create phylogenetic tree for scientific writing

CO No.	**Course Outcome** Upon completion of this course, students will be able to	**PSOs Addressed**	**CL**
CO1	Describe the applications of computer science in biology	PSO1, PSO4 &PSO5	R, Ap
CO2	Explain presentations in MS PowerPoint	PSO2, PSO5	Ap, C
CO3	Apply programming languages and make use of databases in Bioinformatics	PSO1, PSO2, PSO5& PSO6	Ap, E
CO4	Compare sequence alignment using bioinformatics tools	PSO1, PSO2, PSO5	An, E
CO5	Test DNA sequences using phylogenetic analysis for application in research and industrial sectors	PSO2, PSO3, PSO4& PSO6	E& C
CO6	Adapt DNA microarray in diagnostics and research	PSO1, PSO3, PSO4 &PSO6	U, Ap

Unit I **Hours: 15**

Introduction to Computers. Generations of Computer development, Types of computers. Input and output devices. Computing Platforms – Windows, Macintosh, Unix and Linux. Web Page creation using HTML. MS Word, MS PowerPoint, MS Excel.

Unit II **Hours: 12**

Introduction to Internet, WWW, Web browsers, Network basics – LAN, WAN, WLAN. Application of Computers in Military, Education, Industry and Diagnostic Microbiology.

Unit III **Hours: 18**

Introduction to Bioinformatics, Research area and Challenges in Bioinformatics. Programming Languages in Bioinformatics – PERL and PYTHON. Database systems. Importance of biological databases. Primary and secondary databases- sequence and structure databases. Genomic databases. Scoring matrices- PAM, BLOSUM. Heuristic database search methods- BLAST and FASTA. Primer design and validation tools.

Unit IV **Hours: 18**

Sequence alignment: Local and global alignment – Sequence Similarity methods - Dot Matrix and Algorithms. Pairwise sequence alignment and its tools. Multiple Alignments: Progressive and iterative alignment and tools based on these algorithms- Clustal Omega and MultiAlign. Phylogenetic analysis and its tools.

Unit V **Hours: 15**

Microarray - DNA & Protein arrays. Drug discovery - Structure based drug designing and virtual screening by automated docking; Computer Aided Drug design -Molecular docking and evaluation of docking prediction. Introduction to systems microbiology.

Text Books:

1. Arthur M. Leak. (2019). Introduction to Bioinformatics. 5th edition. Oxford University Press
2. Dave Taylor. (2000). HTML 4.0. Tata McGraw –Hill Publishing Company Ltd, 2nd ed, New Delhi.
3. Paul Mcfedries. (2016). My Microsoft office. Sams publishing techmedia, New Delhi.
4. HH Rashidi & LK Buehler. (2002). Bioinformatics Basics: Applications in BiologicalScience and Medicine, CRC Press, London
5.David W. Mount. (2004). Bioinformatics: Sequence and Genome Analysis. Cold SpringHarbor Laboratory Press.

Suggested reading:

1. Des Higgins & Willie Taylor. (2002). Bioinformatics: Sequence, structure and databanks, Oxford University Press
2. Arthur M. Lesk. (2013). Introduction to Bioinformatics. 4th Edition. Oxford University press.
3.L. AlberghinaH.V. westerhoff. (2005). Systems Biology: Definitions and perspectives. Springer.
4. Brown, Stuart M. (2000). Bioinformatics: A Biologist's Guide to Biocomputing and the Internet. Eaton Publishing Company/Bio Techniques Books Division.

References:

1. Andreas D. Baxevanis, Gary D. Bader, David S. Wishart (2022). Bioinformatics: A Practical Guide to the analysis of genes and proteins. Wiley
2. Westhead, Parish and Twyman. (2002) Instant notes in Bioinformatics. Taylor & Francis Publications.
3. Bibekanand Mallick. (2008). Bioinformatics: Principles and Applications. Oxford University press.
4. Özlem Taştan Bishop. (2014). Bioinformatics and Data Analysis in Microbiology. Caister Academic Press.
5. Brian D. Robertson and Brendan W. Wren. (2012). Systems Microbiology: CurrentTopics and Applications. Caister Academic Press.

Online Resources:

1. https://edu.gcfglobal.org/en/computerbasics/
2. http://ecoursesonline.iasri.res.in/course/view.php?id=160
3. https://nptel.ac.in/courses/102106065
4. https://guides.library.uq.edu.au/bioinformatics
5. http://ecoursesonline.iasri.res.in/mod/page/view.php?id=5073

Semester III – Core Paper
Microbial Genetics, Molecular Biology and rDNA Technology

(Candidates admitted from the academic year 2022 – 2023)

Total Hours: 78 **Credits: 5**

Learning Objectives	
(i)	To understand the concepts of Microbial genetics and molecular biology
(ii)	To learn gene transfer mechanisms and selection of recombinants
(iii)	To study the importance of various molecular techniques in diagnosis
(iv)	To provide in depth knowledge in gene expression and regulation
(v)	To learn the importance of Mutations.

CO No.	**Course Outcome** Upon completion of this course, students will be able to	**PSOs Addressed**	**CL**
CO1	Acquire basic knowledge in genomics, gene expression and regulation.	PSO1, PSO2	R
CO2	Explain the methods of manipulating genes and proteins for fundamental research.	PSO1, PSO2, PSO3, PSO 4 & PSO 6	U
CO3	Apply the principles and techniques of molecular biology in research and diagnostics.	PSO2, PSO 3, PSO4, PSO6	R, Ap
CO4	Analyze the mechanisms of gene transfer for genomic mapping	PSO1, PSO2	An
CO5	Perceive the importance of PCR in the construction of genomic libraries.	PSO1, PSO2, PSO 3 & PSO 4	R,An
CO6	Elaborate on genetic analysis of mutants.	PSO1, PSO2, PSO3, PSO4, PSO6	U, Ap

Unit – I **Hours: 15**

Historical perspectives of Microbial genetics and Molecular biology- Overview of Mendelian Genetics- Nucleic acids as genetic material- discovery, elucidation of structure and properties- repetitive DNA-linking number-heterochromatin & euchromatin-gene concept.

Unit – II **Hours: 18**

Organization of prokaryotic genetic material (nucleoid) and eucaryotes (chromosomes, ploidy and nucleosomes), Molecular mechanism of DNA replication in prokaryotes and eukaryotes. Gene expression-transcription-types of RNA polymerases-DNA footprinting-promoters, enhancers and silencers-post transcriptional modification, Genetic code, translation, post translational modification.

Unit – III **Hours: 15**

Gene regulation –An overview on levels of regulation-Operon Concept-Positive and negative regulation in E.coli-Lac Operon and Ara operon, regulation by attenuation-Trp Operon. Eukaryotic

gene regulation. Gene transfer mechanism- transformation, Conjugation and transduction. Gene mapping in E.coli & Yeast. Introduction to Phage Genetics.

Unit – IV **Hours: 12**

Tools of recombinant DNA technology-Restriction enzymes- types and properties, DNA joining enzymes- (ligase, topoisomerase, recombinase) and oligonucleotides-linkers, adapters, homopolymer tailing. Source DNA-genomic DNA, synthetic DNA and cDNA. PCR and its types. Vectors –plasmid, phage, cosmid, shuttle and expression vectors. Cloning hosts-E.coli and Yeast, Cloning strategies. Construction of genomic and c-DNA libraries, screening and isolation of recombinants- reporter genes,

Unit – V **Hours: 18**

DNA sequencing methods- Next Generation Sequencing methods, Comparative genomics. Metagenomics and Metabolomics-brief introduction. Proteomics -analysis of protein expression, Mutation and Mutagenesis- Molecular mechanism of mutation – genetic analysis of mutants, DNA damage and repair-Types of damage and repair mechanisms. Genetic Disorders due to mutations. Carcinogenicity testing (Ames test). Genetic recombination-Molecular models of recombination & transposons-Structure of bacterial transposons and molecular mechanism of transposition.

Text Books:

1. David Freifelder. (1995). Molecular Biology. Narosa Publ. House.
2. Sivarama Sastry *et al. (*1994). Textbook of Molecular Biology. Macmillan India Ltd.
3. T. A Brown. (2006).Gene Cloning and DNA Analysis – An Introduction. Fifth edition, Blackwell Pub.
4.Old and Primrose. (2001). Principles of Gene Manipulation: An introduction to genetic engineering. 6th ed. Blackwell Scientific Publ.
5. David Freifelder, John Cronan and Stanly R. Maloy. (2009). Microbial Genetics. 2nd Edition. Narosa publishing house.
6.Keya Chaudhuri. (2012). Recombinant DNA Technology. The Energy and Resources Institute, TERI

Suggested Reading:

1. Klug WS *etal.* (2021). Concepts of Genetics 12th Ed. Pearson publishing.
2. Hartwell *eta*l. (2021) Genetics from gene to genome. 5th ed. Mc Hill publication.
3. Robert RH Anholt, Trudy FC Mackay (2021) Principles of Behavioural Genetics. Academic Press.

References:

1. Jocelyn E. Krebs. (2018). Lewin's GENES XII. Jones & Barlett learning. LLC.
2. Michael R. Green (2014). Molecular Cloning: A laboratory manual,4th ed. Cold spring Harbor laboratory press.
3. Snustad & Simmons. (2015). Principles of Genetics 7th ed. Wiley Publishers.
4. Benjamin A. Pierce. (2014). Genetics: a conceptual approach. Elsiever.

Online resources:

1.https://cshl.libguides.com/c.php?g=474065&p=3243790

2.https://www.genome.gov/genetics-glossary/Gene-Regulation

3.https://old.amu.ac.in/emp/studym/100004147.

4.https://www.vedantu.com/biology/tools-of-recombinant-dna-technology

Semester III – Core Practical
Microbial Genetics, Molecular Biology and rDNA Technology

(Candidates admitted from the academic year 2022 – 2023)

Total Hours: 65 **Credits: 3**

Learning Objectives	
(i)	To acquire hands-on training on molecular methods
(ii)	To learn the isolation protocols of DNA and RNA
(iii)	To understand and perform gene transfer experiments
(iv)	To analyze the protein by SDS-PAGE and Western Blotting
(v)	To amplify gene using PCR.

CO No.	**Course Outcome** Upon completion of this course, students will be able to	**PSOs Addressed**	**CL**
CO1	Acquire knowledge in genome extraction	PSO1, PSO2, PSO3 & PSO4	U
CO2	Explain the role of genes in determining the traits of drug resistant organisms	PSO1, PSO2, PSO3, & PSO4	U, Ap
CO3	Apply the practical knowledge in clinicaldiagnosis, research and other industries	PSO1, PSO2, PSO3, PSO4, PSO6	U, Ap,
CO4	Analyze the nature of proteins using SDS PAGE	PSO1, PSO2, PSO3, PSO4 &PSO6	An
CO5	Perform PCR for molecular diagnosis	PSO1, PSO2, PSO3, PSO4 &PSO6	U, Ap
CO6	Evaluate Mutations through molecular methods	PSO1, PSO2, PSO3, PSO4, PSO6	An, E

1. Quantitative estimation of DNA and RNA-Colorimetric and UV absorption methods.
2. Isolation of plasmid DNA by alkali lysis method.
3. Isolation of chromosomal DNA from bacteria.
4. Isolation of RNA from yeast.
5. Restriction digestion of DNA.
6. Ligation of DNA.
7. Transformation in E.coli.
8. Protein separation by SDS-PAGE.
9. Western blotting
10. Restriction mapping of λ phage.
11. Demonstration of Conjugation in E.coli.
12. Gene Amplification using PCR.
13. Computer-based genetic tools - Demonstration

Text books:

1. Chowdhury Madhumita Roy. (2014). Laboratory Manual for Molecular Genetic Tests, Jaypee Brothers Medical Publishers.
2. Pranab Paul, Dr.BhaskarSarma. (2022). Molecular Biology with Practical, Mahaveer Publications

References:

1. Suphiya khan, Swati Agarwal (2019) Advanced Lab Practices in Biochemistry & Molecular Biology,Wiley Publications
2. Sue Carson, Heather Miller, Melissa Srougi, D. Scott Witherow (2019), Molecular Biology Techniques - A Classroom Laboratory Manual, Academic press.

Online Resources:

1.https://www.csus.edu/indiv/p/peavyt/184/lab%20manual/experiment3%20recombinant%20molecules.pdf
2.https://faculty.ksu.edu.sa/sites/default/files/bch361_handnote_1.pdf
3.https://ruo.mbl.co.jp/bio/e/support/method/westernblotting.html
4.http://www.nbpgr.ernet.in/Portals/6/DMX/GENOMIC_RESOURCES/DNA%20extraction-Comparison%20of%20methodologies.pdf

Semester III – Core Paper
Food, Dairy and Pharmaceutical Microbiology

(Candidates admitted from the academic year 2022 – 2023)

Total Hours: 78 **Credits: 5**

Learning Objectives	
(i)	To get acquainted with the role of a microbiologist in food, dairy and pharmaceutical industries
(ii)	To understand the processes of commercial manufacture of fermented products
(iii)	To analyze food, dairy and pharmaceutical products for microbiological quality
(iv)	To be cognizant of the microbiological standards of food and pharmaceutical products
(v)	To know about various certification systems in food and pharmaceutical industries

CO No.	**Course Outcome** Upon completion of this course, students will be able to	**PSOs Addressed**	**CL**
CO1	Describe the application aspects of microbiology in food, dairy and pharmaceutical sectors, particularly with reference to preservation processes and shelf life	PSO1, PSO2, PSO6	R, U
CO2	Understand the commercial production of fermented food, dairy and pharmaceutical products, and quality control, GMP and HACCP processes	PSO1, PSO2, PSO4, PSO6	U, Ap
CO3	Apply the knowledge gained to perform experiments for microbiological analysis of food, dairy and pharmaceutical samples	PSO1, PSO2, PSO4, PSO6	Ap, An
CO4	Compare the microbial standards and limits prescribed by various agencies and correlate the requirements with reference to regional standards	PSO1, PSO2, PSO4, PSO6	An, E
CO5	Evaluate the microbiological quality of food, dairy and pharmaceutical products based on the microbiological analysis and their standards thereof	PSO1, PSO2, PSO4, PSO6	An, E
CO6	Discuss about various certification systems and auditing protocols, and adapt themselves to the industry environment	PSO1, PSO2, PSO6	U, Ap

Unit – I **Hours: 15**

Scope of food microbiology; Food as a substrate for microorganisms; Microorganisms important in food microbiology; Factors influencing microbial growth in food – extrinsic and intrinsic factors. Principles of food preservation, canning, heat treatment – Determination of TDP, TDT,

D, F and Z values. Contamination and spoilage –cereals, vegetables, fruits, meat and meat products, sea foods and poultry. Concept of predictive microbiology in foods.

Unit – II **Hours: 18**

Food-borne infections and intoxication. Microbiological examination of foods. Food from microbes – Fermented foods - Production of sauerkraut, idli, tempeh, soy sauce, natto - GM foods - Food safety, quality control and HACCP - food control and licensing agencies, Food standards– FSSAI, Codex Alimentarius. Certification systems – ISO 22000, FSSC 22000, FDA, BRC, Halal and Kosher. Food auditing.

Unit – III **Hours: 12**

Dairy microbiology: Scope and Introduction – Composition of milk, sources of microbial contamination of milk and types of microorganisms in milk –Microbiological spoilage of milk – Microbiological examination of milk – Principles and methods of industrial pasteurization – Concept of probiotics, prebiotics, synbiotics and postbiotics. Commercial manufacture of cheese, butter, acidophilus milk, yoghurt, kefir and koumiss.

Unit – IV **Hours: 18**

Ecology of microorganisms in pharmaceutical industry – Water analysis and area monitoring - Microbial contamination, spoilage and standards of various pharmaceutical products –Sterile and non-sterile pharmaceutical products – Microbial limit test of pharmaceutical products - Sterility testing and pyrogen testing - Antibiotic bioassays: diffusion assays, transferase assays – luciferase assays - HPLC in drug analysis.

Unit – V **Hours: 15**

Pharmaceutical products from microorganisms – Commercial production of penicillin, streptomycin, bacterial vaccines, viral vaccines - Quality control and Quality assurance in pharmaceutical industries – Good pharmaceutical manufacturing practices (GPMP/GMP) in pharmaceutical industries – Regulatory authorities and their role in drug standards, quality and safety – certification systems.

Text Books:

1. Adams M.R., Moss M.O. and McClure P. (2016). Food microbiology. 4th edition. The Royal Society of Chemistry, Cambridge, UK.
2. Frazier W.C.Westhoff D.C, and Vanitha N.M. (2017). Food Microbiology. 4th edition, McGraw Hill Education.
3. Robinson R.K. (2005). Dairy Microbiology Handbook 3rd edition. Wiley Interscience.
4. Denyer S.P., Hodges N., Gorman S.P. and Gilmore B. (2011). Hugo and Russell's Pharmaceutical Microbiology. 8th edition, Wiley-Blackwell.

Suggested Reading:

1. Dairy Microbiology and Biochemistry. (2014). Edited by Ozer B. and Evrendilek G.A., CRC Press, Boca Raton.

2. Kokare C. (2020). Pharmaceutical Microbiology. NiraliPrakashan.
3.Jay J.M., Loessner M.J., David A. (2005). Modern Food Microbiology. Seventh Edition.Springer Publishing, USA.

References:

1. Food Safety Management. (2014). Edited by Motarjami Y and Lelieveld H. Academic Press, Elsevier.
2. Sandle T. (2016). Pharmaceutical Microbiology: Essentials for Quality Assurance and Quality Control. Woodhead Publishing, Elsevier.
3. Microbiology in Pharmaceutical manufacturing. (2008). 2nd Edition. Vol I & II edited by Richard Prince. Published by PDA.
4. Mehra P.S. (2011). A textbook of Pharmaceutical Microbiology. I.K. International Publishing House Pvt. Ltd.

Online Resources:

1.https://www.classcentral.com/course/swayam-food-microbiology-and-food-safety-17609
2.https://nptel.ac.in/courses/126103017
3.https://archive.nptel.ac.in/courses/126/105/126105013/
4.http://ecoursesonline.iasri.res.in/course/view.php?id=107

Semester III – Core Practical
Food, Dairy and Pharmaceutical Microbiology

(Candidates admitted from the academic year 2022 – 2023)

Total Hours: 65 **Credits: 3**

Learning Objectives	
(i)	To describe the microbiological analytical protocols pertaining to food, dairy and pharmaceutical industries.
(ii)	To summarize various microbiological analyses related to food and dairy products.
(iii)	To perform microbiological analysis of sterile and non-sterile pharmaceutical formulations.
(iv)	To know about FSSAI and Indian Pharmacopoeia guidelines and microbiological standards.
(v)	To relate the quality control / in-process results to the prescribed standards by the governing bodies

CO No.	**Course Outcome** Upon completion of this course, students will be able to	**PSOs Addressed**	**CL**
CO1	Acquire experimental skills in food, dairy and pharmaceutical microbiology.	PSO1, PSO2, PSO4& PSO 6	R, U
CO2	Understand the nuances in sample collection, and processing.	PSO1, PSO2, PSO4& PSO 6	U, Ap
CO3	Apply the acquired skill sets in analysing the in-process as well as finished goods.	PSO1, PSO2, PSO4, PSO5& PSO6	Ap, An
CO4	Appraise on the FSSAI and Pharmacopoeia standards.	PSO1, PSO2, PSO4& PSO 6	R, Ap,
CO5	Recommend the product quality with respect to prescribed standards as applicable.	PSO2, PSO4	Ap, An
CO6	Integrate the acquired experimental skills into industrial process and quality control.	PSO2, PSO4, PSO5&PSO6	An, E

1. Enumeration of bacteria in milk by standard plate count method and breed count method.
2. Dye reduction test - Methylene blue test, Resazurin test.
3. Microbiological analysis of food samples: bakery products, creams and spreads, fruits, vegetables.
4. Microbiological analysis of fermented / non-fermented milk products – yoghurt, curd and ice creams.
5. Isolation of lipolytic organisms from butter.
6. Design of HACCP plan / flow chart for any one food product.
7. Microbial limit test of raw materials/excipients/packing materials used in pharmaceutical manufacturing.

8. Sterility testing of injectables, saline, ophthalmic preparations, surgical cotton, gauze, surgical gloves, and soluble powders.
9. Determination of microbial load in non-sterile pharmaceuticals (syrups/tablets/creams/pharmacognostic formulations).
10. Determination of surface microbiological quality of autoclaves/vessels/incubators by contact plate method.
11. Swab testing of irregular surfaces/operators' hands.
12.Microbiological quality of air in sterile areas/filtration chambers.
13.Bacterial endotoxin test.

Text Books:

1. Mukerji K.G. (2013). Laboratory Manual of Food Microbiology. I. K. International Pvt. Ltd.
2. Mandal S. (2011). Laboratory Manual on Introductory Dairy Microbiology. ICAR-NDRI, Karnal.
3. Prasad G.S., Srisailam K. (2019). Pharmaceutical Microbiology: A Laboratory manual. Pharmamed Press.

References:

1. Yousef A.E., Waite-Cusic J.G., Perry J.J. (2022). Analytical Food Microbiology: A Laboratory Manual. (2nd Edition). Wiley.
2. Roberts D., Greenwood M. (2003). Practical Food Microbiology (3rd Edition). Blackwell Publishing.
3. Pharmaceutical Microbiology Manual. (2020). Doc. No. ORA.007 / Revision ≠: 2. Food and Drug Administration (FDA).

Online Resources:

1.https://nptel.ac.in/courses/126103017
2.https://www.classcentral.com/course/swayam-food-microbiology-14063

Semester III – Elective Paper

Health Research, Pharmacovigilance and Pharmaceutical regulatory affairs

(Candidates admitted from the academic year 2022 – 2023)

Total Hours: 78 **Credits: 5**

Learning Objectives	
(i)	To understand the concepts related to health promotion and disease prevention.
(ii)	To learn Adverse drug reaction and its management
(iii)	To know about the pharma regulatory procedures.
(iv)	To know post-marketing surveillance of drugs and tools used in Pharmacovigilance.
(v)	To understand the importance of drug safety monitoring and the development of pharmacovigilance programs.

CO No.	**Course Outcome** Upon completion of this course, students will be able to	**PSOs Addressed**	**CL**
CO1	Recall the concepts of public health and principles of pharmacovigilance practices.	PSO1, PSO3, PSO 4&PSO6	R, U
CO2	Understand the regulatory requirements and guidelines in Pharmacovigilance.	PSO1, PSO3&PSO4	U, Ap
CO3	Apply pharma regulatory practices and procedures.	PSO2, PSO3, PSO4&PSO6	Ap, E
CO4	Discover common challenges encountered during a disease outbreak and select ways to address them.	PSO3, PSO4 & PSO6	U, Ap
CO5	Evaluate the effect of drug-drug interactions and medication errors on human health.	PSO1, PSO2, PSO3&PSO4	Ap, E
CO6	Plan for various methods to collect ADR-related reports	PSO3, PSO4&PSO6	U, An

Unit I **Hours: 15**

Definition of Health – WHO definition. Concepts of Health - Biomedical concept, Ecological concept, psychological and holistic concepts. The practice of public health – Measures of public health. Impact of health care on population health – usage of health services –purpose and methods of health impact assessment.

Unit II **Hours: 15**

Evolution of human disease–emerging and re-emerging infectious diseases–factors affecting the growth and spread of infectious disease – control of infectious disease. Health effects of smoking – diet and health nutrition. Importance of environmental sanitation and personal hygiene. Management of communicable diseases during an outbreak.

Unit III **Hours: 12**

Introduction to Pharmacovigilance: Objectives and scope of Pharmacovigilance. Types and mechanisms of ADRs, Risk factors associated with ADRs. Management of ADRs. Drug–drug interactions. Medication errors. Choice of Therapy, identification of therapeutic problems, Drug use in multiple illnesses - combined therapies.

Unit IV **Hours: 18**

Good Pharmacovigilance practices (GPP): Pre-Marketing and Post-Marketing Methodologies in Pharmacovigilance - Reporting to regulatory authorities – individual case safety reports, periodic safety update reports. Principles of using approved names vs. brand names, non-text book information. Updating product labeling.

Unit V **Hours: 18**

Pharmaceutical Regulatory Affairs in USA, EU and India. Indian Pharma Regulatory- CDSCO, MD (medical devices) online, Sugam portal. Preparation of devices Master file and validation report. Drug discovery, Clinical drug development/Trial Phases and drug licensing in India. Regulations and guidelines for rDNA research – IBSC.

TextBooks:

1.S.K. Gupta. (2011). Textbook of Pharmacovigilance. ICRI Institute Clinical Research (India). Jaypee Publications.
2.K. Park. (2021). Park's textbook of Preventive and Social Medicine, 12th edition, Banarsidas Bhanot Publishers.
3.P. C. Dandiya, Z. Y. K. Zafer, AfifaZafar. (2008). Health Education and Community Pharmacy, 5th edition, publisher: Vallabh Prakashan.
4.Elizabeth B. Andrews (Editor), Nicholas Moore (Editor).(2014). Mann's Pharmacovigilance. 3rd Edition. Wiley-Blackwell Publications.
5. Javed Ali, Sanjula Baboota (Editors). (2021). Regulatory Affairs in the Pharmaceutical Industry, Academic Press, Elsevier

Suggested reading:

1.Baweja Himanshu. (2019). Essentials of Pharmacovigilance Jaypee Brothers Medical Publishers.
2.KPR Chowdary. (2021). A Textbook of Clinical Research and Pharmacovigilance. PharmaMed Press / BSP Books.
3.Paul Torren and Stephen Williams. (2007). Introduction to health services. Publisher - Delmar Cengage Learning

References:

1.Janet Woodcock, Frederick Ognibene, John Overbeke. (2003). Assuring Data Quality and Validity In Clinical Trials For Regulatory Decision Making. Welly Publication.
2.BartenCohert (2011). Cobert's Manual of Drug safety and Pharmacovigilance.2nd Edition. Jones and Bartlett Publishers, Inc.
3.Judith Green Nicki Thorogood. (2014).Qualitative methods for Health Research, 3rd Edition. SAGE Publications,Inc.
4.Greg Guestan Emily E.Namey.(2015).Public Health Research Methods. SAGE Publications, Inc.
5.Ravi Humbarwadi. (2016). Clinical Research and Pharmacovigilance. CreateSpace Independent Publishing Platform.

Online Resources

1.https://fwtrc.gov.in/content/e-book
2.https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4576445/
3.https://www.classcentral.com/course/swayam-health-research-fundamentals-5218
4.https://globalpharmacovigilance.com/free-online-pharmacovigilance-cour

Semester III – Elective Paper
Entrepreneurship in Microbiology

(Candidates admitted from the academic year 2022 – 2023)

Number of Hours: 78 **Credits: 5**

Learning Objectives	
(i)	To learn the concept and scope of entrepreneurship.
(ii)	To know about the skills of entrepreneurs, market research, financial plan and funding agencies.
(iii)	To learn about project planning and management, and the concepts of branding and advertising.
(iv)	To understand the concepts of knowledge centers, technology development and transfer, and IPR in biotechnology businesses.
(v)	To know the characteristics of an entrepreneur and available bio-business opportunities.

CO No.	Course Outcome Upon completion of this course, students will be able to	PSOs Addressed	CL
CO1	Define the characteristics and skills for being a successful entrepreneur	PSO1, PSO2& PSO4	R
CO2	Outline project planning for management of a biobased technology	PSO1, PSO2, PSO3& PSO6	U, Ap
CO3	Identify potential entrepreneurship opportunities in the field of life sciences	PSO1, PSO2, PSO3, PSO4	Ap, An
CO4	Discover the need of quality certification systems	PSO1, PSO4	E, C
CO5	Perceive the importance of funding agencies	PSO2& PSO 6	R, Ap
CO6	Choose a domain for becoming a successful bioentrepreneur	PSO1, PSO2, PSO3, PSO4, PSO5&PSO6	Ap,E

Unit – I **Hours: 15**

Entrepreneurship: Concept, nature, scope, and its functional aspects. Concepts of intrapreneurship, self-employment and entrepreneurship. Introduction to bioentrepreneurship. Structure of a Biobased technology company. Start-up of a Biobased technology company. Understanding of Government policies: Ethical and Other Legal Issues in microbial products.

Unit – II **Hours: 18**

Skills for entrepreneurs - communication skills, problem-solving skills. Business plan development. Market need - market research, SWOT analysis, identifying competitors. Preparation of a startup proposal and pitch deck. Financial plan - identifying funding sources for your business - Angel Investors and Government Agencies, insuring your business, Marketing - mix - product, distribution, price, promotion.

Unit – III **Hours: 15**

Project Planning and Management: Laboratory Competence, Health and Safety awareness. Budget Planning – Ratio analysis, Investment Process, Break even analysis, Profitability analysis. Funding agencies and schemes in India – SIDBI, SSIDC, BIRAC-BIG, Nidhi prayas, NIDHI-EIR, EDII-TN, NSIC. MSME Act, Small Scale Industries. Advertising and Branding: Introduction, Choice of Media, Message, Measuring effectiveness of advertising. Branding: Concepts and benefits, Packaging & Labeling.

Unit – IV **Hours: 18**

Role of knowledge centers in biotechnology businesses: Universities and research institutions. Technology development for microbial products, Assessment of scaling up of technology, Technology transfer: Transfer agencies and regulations. IPR: patents, copyrights, trademarks; invention step, biopiracy and bioprospecting. Quality Management: Quality Concepts & tools, Importance and need for Quality Systems, Quality Standards with special reference to ISO, Quality System Certification Procedures.

Unit – V **Hours: 12**

Successful entrepreneur - Steps, Characteristics. Entrepreneurship opportunities - Composting from domestic waste, agricultural and industrial waste. Vermicomposting - SCP production - Mushroom cultivation. Biofertilizers and biopesticides. Production of teaching kits (plasmid DNA isolation, serum electrophoresis) and diagnostic kits (WIDAL test kits, ABO blood grouping kits), Biopharmaceuticals, fermented microbial product.

Text Books:

1.Martin Gross Mann. (2003). Entrepreneurship in Biotechnology: Managing for growth from start-up
2.D. Hyne& John Kapeleris. (2007). Innovation and entrepreneurship in biotechnology: Concepts, theories & cases
3.Vasant Desai. (2005). Dynamics of Entrepreneurial Development and Management Himalaya Publishing House.

Suggested Reading:

1.Mellor Robert. (2008). Entrepreneurship for Everyone, SAGE Publications.
2.William Bygram and Andrew Zacharakis. (2007). Entrepreneurship, John Willey& Sons.

References:

1**.** Prasannan (2019). Projects Planning Analysis, Selection, Implementation & Review. Publisher: CFM – MHE professionals.
2.Patzelt H., Brenner T. (2008). Handbook of Bioentrepreneurship. Springer, New York.
3.Shimasaki C. (2014). Biotechnology Entrepreneurship - Starting, Managing and Leading Biotech Companies. Elsevier, UK.

Online Resources:

1.https://www.startus-insights.com/innovators-guide/microbiology-startups/

Semester IV – Core Paper
Virology and Mycology

(Candidates admitted from the academic year 2022 – 2023)

Total Hours: 78 **Credits: 5**

Learning Objectives	
(i)	To understand the properties of viruses and their immunodiagnosis
(ii)	To study the genetics of the bacteriophage life cycle
(iii)	To learn the pathogenesis of animal viruses and the usage of viruses as vectors
(iv)	Acquire knowledge on medically important fungi
(v)	To get insights on the immunodiagnostic methods in mycology

CO No.	**Course Outcome** Upon completion of this course, students will be able to	**PSOs Addressed**	**CL**
CO1	Describe the characteristics of medically-important viruses and fungi.	PSO1, PSO3 & PSO4	R,U
CO2	Interpret viral and fungal infections by serodiagnostic techniques.	PSO1, PSO2, PSO3, PSO4& PSO6	Ap, An
CO3	Discover the occurrence of emerging and re-emerging infections	PSO1, PSO2, PSO3, PSO4& PSO6	Ap,An
CO4	Appraise the usage of viral vectors.	PSO1, PSO2, PSO3, PSO4& PSO6	U, Ap
CO5	Evaluate the diagnostic tools available for screening infections.	PSO2, PSO3, PSO4& PSO6	Ap,E
CO6	Choose appropriate viral cultivation methods	PSO1, PSO2, PSO3& PSO4	Ap, An

Unit-I **Hours: 15**

Historical perspectives- Morphology and General properties of viruses-outline of current ICTV classification of viruses, Cultivation of viruses - cell line, embryonated eggs and experimental animals, sub viral agents- viroids, virusoids, and prions. Immunodiagnosis of viral infections.

Unit-II **Hours: 18**

Life cycle of Bacteriophages: lytic and lysogenic cycle- One step growth curve. General life cycle of bacteriophages: Øx174, M13, Mu, T4, λ, and P1 phages. Plant viruses: Brief life cycle of type species of plant viruses-TMV and Cauliflower mosaic viruses, management of plant viral infections. Phage typing.

Unit-III **Hours: 18**

Algal viruses, Mycophages, Insect Viruses-Brief lifecycle. Laboratory diagnosis and pathogenesis of Animal viruses: DNA viruses - Adeno, Pox, Herpes and Hepadna viruses. RNA viruses- Polio, Rabies and Retroviruses. Arboviruses: Dengue & Chikungunya, Ebola, H1N1 virus. Other emerging viral diseases - SARS CoV 2, Viral vaccines and drugs. Viral vectors.

Unit-IV **Hours: 15**

Morphology, Taxonomy, classification of fungi, detection & recovery of fungi from clinical specimen. Dermatophytes and agents of superficial mycoses. Trichophyton, Epidermophyton &Microsporum. Yeasts of medical importance – Candida, Cryptococcus – Mycotoxins, Antifungal agents, testing methods and quality control.

Unit-V **Hours: 12**

Dimorphic fungi causing systemic mycoses, Histoplasma Coccidioides: sporothrix, Blastomyces. Opportunistic fungi: - fungi causing Eumycotic Mycetoma. Fungi causing secondary infections in immunocompromised patients. Immunodiagnostic methods in mycology-recent advancements in diagnosis.

Text Books:

1.Nigel Dimmock., Andrew Easton., Keith Leppard. (2007). Introduction to Modern Virology, Sixth edition. Blackwell publishing.

2.S.J. Flint., L.W. Enquist., V.R. Racaniello., A.M. Skalka. (2009). Principles of Virology, Third edition. ASM Publishers.

3.K. Smith. (2020). Introduction to Virology, SPRINGER Publishing.

4.JagdishChander (2018). Textbook of Medical Mycology, fourth edition, Jaypeebrothers medical publishers.

5.C.J. Alexopoulos, C.W. Mims, M. Blackwell, (2007). Introductory Mycology, Fourth edition. Wiley publishers.

Suggested Reading:

1.Flint SJ, Enquist LW, King RM, Racaniello VR and Shalka AM (2000). Principles of Virology - Molecular Biology, pathogenesis and control, ASM Press,Washington DC.

2.P. Saravanan. (2006). Virology, MJP Publishers, Chennai.

3.Ananthanarayanan, R. and Jayaram Panicker C.K. (2004) Textbook of Microbiology.Orient Longman, Hyderabad

References:

1.Edward K. Wagner, Martinez J. Hewlett, (2004). Basic Virology, Blackwell Publishing

2.Dennis H. Bamford, Mark Zucherman, (2021). Encyclopedia of Virology, Fourth edition. Elsevier.

3.Topley and Wilson (1995) Principles of Bacteriology Virology and Immunity. 9th Edn. Vol I, Edward Arnold, London.

4.Douglas D. Richman, Richard J. Whitley, Frederick G. Hayden, (2016). Clinical Virology, fourth edition.ASM Press.

5.Kevin Kavanagh, (2018). Fungi Biology and Applications 3rd Edition. Wiley Blackwell publishers.

Online resources:

1.http:// www.virology.net/garryfavwebaids.html

2.http:// www. virology.net/garryfavwebaids.html≠genaids

3.http://users.ox.ac.uk/-genemed/virology.htm

Semester IV – Core Practical
Virology and Mycology

(Candidates admitted from the academic year 2022 – 2023)

Total Hours: 52 **Credits: 3**

Learning Objectives	
(i)	To learn the practical techniques in Virology and Mycology
(ii)	To prepare viral vaccines by cultivation in embryonated eggs
(iii)	To isolate and enumerate the bacteriophages for analysis of environmental samples
(iv)	To cultivate and identify different fungi
(v)	To identify and differentiate dermatophytes

CO No.	**Course Outcome** Upon completion of this course, students will be able to	**PSOs Addressed**	**CL**
CO1	Acquire practical skills in Virology and Mycology	PSO1, PSO2, PSO3& PSO4	U
CO2	Infer the route of viral cultivation using embryonated eggs	PSO1, PSO2	Ap, An
CO3	Identify common fungi based on microscopic observation	PSO1, PSO2, PSO3 & PSO4	U, Ap
CO4	Demonstrate the vegetative and reproductive fungal structures	PSO1, PSO2, PSO3 & PSO4	Ap, An
CO5	Perceive the symbiotic association of fungi with plant roots by identifying VAM spores	PSO1, PSO2	An
CO6	Choose appropriate method for fungal diagnosis	PSO3, PSO4	E

1. Isolation of phages from sewage.
2. Titration of phages.
3. Egg inoculation of viruses-different routes-Allantoic, amniotic, yolk sac and CAM.
4. Observation of viral inclusion bodies (slides).
5. Identification and Classification of common fungi.
6. Mounting and staining of VAM spores.
7. Examination of different fungi by Lactophenol cotton blue staining.
8. Examination of different fungi by KOH staining.
9. Cultivation of fungi and their identification - Mucor, Rhizopus, Aspergillus, Penicillium.
10. Microscopic observation of different asexual fungal spores.
11. Microscopic observation of fungal fruiting bodies.
12. Identification of Dermatophytes.

Text books:

1.Subash Chandra Parija. (2012). Textbook of Practical Microbiology. Ahuja publishing house.
2.Cappuccimo, J. and Sherman, N. (2002). Microbiology: A Laboratory Manual, 6th Edn. Pearson Education Publication, New Delhi

References:

1.Mackie & McCartney Practical Medical Microbiology (2008),14th edition. Elsevier, New Delhi.
2.Kwon-Chung K.J and Bennett JE. (1992). Medical Mycology. Lea and Febiger, Philadelphia, USA

Online resources:

1.https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7173454/
2.https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3768729/
3.https://www.ncbi.nlm.nih.gov/pmc/articles/PMC149666/

Semester IV – Core paper
Microbial Technology and IPR

(Candidates admitted from the academic year 2022 – 2023)

Total Hours: 65 **Credits: 5**

Learning Objectives	
(i)	To learn about the types of fermentation, fermenter designs and optimization of parameters
(ii)	To know about the industrially important microorganisms, strain improvement, inoculum development, media formulation and cultivation.
(iii)	To learn about the commercial production of various fermented products
(iv)	To understand about downstream processing of products
(v)	To acquire fundamental knowledge on Intellectual Property Rights (IPRs).

CO No.	**Course Outcome** Upon completion of this course, students will be able to	**PSOs Addressed**	**CL**
CO1	Describe the industrial fermentation processes	PSO1, PSO2	R, U
CO2	Demonstrate the significance of microorganisms in industrial fermented products	PSO1, PSO 2 &PSO6	Ap, An
CO3	Illustrate various upstream processes	PSO1, PSO2, PSO4&PSO6	Ap, An
CO4	Explain methods of downstream processes	PSO1, PSO2 & PSO4& PSO6	U, Ap
CO5	Choose appropriate fermentation processes/types for the production of various products	PSO1, PSO2, PSO3& PSO6	R, Ap
CO6	Create commercial opportunities for novel fermented products through IP generation	PSO1, PSO2, PSO4&PSO6	Ap, C

Unit – I **Hours: 15**

Fermentation – Definition, Brief history and developments in fermentation. Primary and Secondary metabolites, Types of fermentation –Batch,fed-batch and continuous fermentation and Solid state. Fermenters – Design, Components, Types and Sterilization. Optimization of fermentation parameters – pH, temperature, foaming, nutrients and mass transfer, aeration and agitation. Fermentation kinetics.

Unit – II **Hours: 10**

Industrially important microorganisms - Isolation, preservation, screening and strain improvement. Upstream processing - development of inoculum for various fermentation processes - media for industrial fermentation and its sterilization.

Unit – III **Hours: 15**

Downstream processes: Intracellular and extracellular product recovery - filtration, centrifugation, sedimentation, emerging technologies for cell recovery, cell lysis methods: mechanical, chemical and biological, product isolation, extraction, solvent extraction, aqueous two-phase system, sorption, precipitation, reverse osmosis, ultra-filtration.

Unit – IV **Hours: 15**

Fermentation of microbial products – Single Cell Protein (SCP). Non-distilled beverages (beer and wine) and Distilled beverages (Whisky and Brandy). Aerobic fermentation (vinegar and citric acid). Vitamins (B12, riboflavin), Hormone (IAA). Enzyme (amylase, protease), Amino acids (Lysine, tryptophan). Modern trends in microbial production - Bioplastics (PHB, PHA), Biopolymers (Dextran, Agar-agar), Biosurfactants, Probiotics, Nutraceuticals. Microbial Enhanced Oil Recovery (MEOR), Bioconversion and Biotransformation of steroids.

Unit – V **Hours: 10**

Intellectual Property Rights (IPR), Patents - Concept and Need for patents, Patenting of biological materials. Trademarks, Copyrights, Trade secrets, Industrial designs. Patenting of Traditional Knowledge, Patenting of transgenic organisms, genes and DNA sequences. Patent process in India, Filing and Forms – Provisional and complete specification. International patenting: World Intellectual Property Organization (WIPO), Patent Cooperation Treaty (PCT).

Text Books:

1.Samuel C. Prescott. (2016). Industrial Microbiology. Agrobios (India) Publishers.
2.L.E. Casida. (2016). Industrial Microbiology. 2nd Edition. New Age International.
3. Nduka Okafor, Benedict C. Okeke. (2017). Modern Industrial Microbiology and Biotechnology. CRC Press.
4.Waites M.J., Morgan N.L., Rockey J.S. and Higton G. (2001). Industrial Microbiology: An Introduction. 1st edition. Wiley – Blackwell.

Suggested Reading:

1.Fogarty W.M. & Kelly C.T. (2012). Microbial Enzymes and Biotechnology (2nd edition). Elsevier Applied Science.
2.Goldberg E. (2012). Handbook of Downstream Processing. Blackie Academic & professional, Chapman and Hall.
3.Singh K.K. (2014). Biotechnology and Intellectual Property Rights: Legal and Social Implications. Springer
4.S. Sivasubramanian & T. Hemalatha R. Puvanakrishnan (2021). Microbial Technology: Concepts and Applications. MJP Publisher.

References:

1. Peter F. Stanbury, Stephen J. Hall, and Allan Whitaker. (2016). Principles of Fermentation Technology. 3rd Edition. Butterworth-Heinemann publishers.
2. H.J. Peppler and D. Perlman. (2014). Microbial Technology: Fermentation Technology, Second Edition, Elsevier Science. Academic Press, INC.

Online Resources:

1.https://nptel.ac.in/courses/109106100
2.https://study.com/academy/topic/food-and-industrial-microbiology-tutoring-solution.html
3.https://nptel.ac.in/courses/102105058

Semester IV – Core Practical
Microbial Technology and IPR

(Candidates admitted from the academic year 2022 – 2023)

Total Hours: 52 **Credits: 3**

Learning Objectives	
(i)	To learn about fermentation processes and media formulation.
(ii)	To screen for industrially important microorganisms and enzymes
(iii)	To understand immobilized fermentation processes
(iv)	To learn about the production of wide range of industrial fermented products
(v)	To estimate the quantity of the obtained fermented product

CO No.	**Course Outcome** Upon completion of this course, students will be able to	**PSOs Addressed**	**CL**
CO1	Describe the process of screening of industrial enzymes	PSO1, PSO2& PSO6	R, U
CO2	Demonstrate the production of fermented products of industrial importance using simple available substrates	PSO1, PSO2, PSO3, PSO4& PSO6	R, An,
CO3	Apply varied procedures used in alcohol and wine production	PSO2& PSO6	Ap, An
CO4	Explain cultivation methods of spirulina, yogurt and mushrooms effectively	PSO1, PSO2, PSO4 & PSO6	Ap, An
CO5	Recommend suitable fermentation processes as per requirements	PSO1, PSO2, PSO4& PSO6	U,An
CO6	Formulate new media composition and use available substrates for the synthesis of novel fermented products.	PSO1, PSO2, PSO4& PSO6	An, C

1. Preparation of wine from grape juice and estimation of alcohol.
2. Immobilization of Microbial cells by entrapment method.
3. Production of alcohol using free and immobilized yeast cells.
4. Production of citric acid using *Aspergillus niger*.
5. Screening of antibiotic-producing organisms from soil.
6. Screening of amylase, cellulase and protease producing organisms from soil.
7. Preparation of Yoghurt
8. Cultivation of Spirulina (SCP)
9. Cultivation of edible mushrooms
10. Estimation of phycobilin from cyanobacteria
11. Production of antimicrobial substances from lactobacilli and demonstration of antibacterial activity of the same
12. Visit to a nearby industry
13. Indian and International patenting process – Demonstration.

Text Books:

1. K.R. Aneja. (2007). Experiments In Microbiology, Plant Pathology and Biotechnology. New Age International.
2. Baltz, Richard H.; Davies, Julian E.; Demain, Arnold L. (2010). Manual of Industrial Microbiology and Biotechnology (3rd Edition). American Society for Microbiology (ASM).
3. K.R. Aneja. (2018). Laboratory Manual of Microbiology and Biotechnology.

References:

1. S. Kulandaivel, S. Janarthanan (2012). Practical Manual on Fermentation Technology. I K International Publishing House Pvt. Ltd.
2. Brian McNeil & Linda M. Harvey (2008). Practical Fermentation Technology. John Wiley & Sons, Ltd.

Online Resources:

1.https://www.pdfdrive.com/manual-of-industrial-microbiology-and-biotechnology-e157635759.html
2.https://www.researchgate.net/publication/344465390_practical_manual_cum_workbook_on_industrial_microbiology

Semester IV – Elective Paper
Nanobiotechnology

(Candidates admitted from the academic year 2022 – 2023)

Total Hours: 52 **Credits: 5**

Learning Objectives	
(i)	To know the field of nanobiotechnology, nano size and classification of nanomaterials.
(ii)	To learn the methods of fabrication of nanomaterials.
(iii)	To acquire knowledge on characterization of nanomaterials.
(iv)	To know the applications of nanomaterials in nanomedicine, its toxicity and assessment of toxicity of nanomaterials.
(v)	To gain knowledge on the applications of nanomaterials in control of environmental pollution.

CO No.	**Course Outcome** Upon completion of this course, students will be able to	**PSOs Addressed**	**CL**
CO1	Acquire knowledge in the field of nanobiotechnology	PSO1, PSO2	R, U
CO2	Understand the changing phenomena of materials at nanoscale, types of nanomaterials and their classification.	PSO1, PSO2	R, U
CO3	Identify various applications of nanomaterials in the field of medicine and environment	PSO1, PSO2, PSO3, PSO4 & PSO6	Ap, An
CO4	Examine the prospects and significance of nanobiotechnology	PSO1, PSO2, PSO3, PSO4& PSO6	An
CO5	Evaluate the recent advances in this area and create a career or pursue research in the field.	PSO2, PSO3, PSO5& PSO6	E
CO6	Design non-toxic nanoparticles for targeted drug delivery	PSO2, PSO3, PSO4 &PSO6	E, C

Unit-I **Hours: 12**

Introduction to nanobiotechnology, Nanosize-changing phenomena at nanoscale, 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 nanomaterials and the risks associated with the materials.

Unit-II **Hours: 10**

Fabrication of Nanomaterials-Top-down and Bottom-up approaches, Solid phase synthesis-milling, Liquid phase synthesis-Sol-gel synthesis, colloidal synthesis, microemulsion method, hydrothermal synthesis and solvothermal synthesis, Vapour/Gas phase synthesis-Inert gas condensation, flame pyrolysis, Laser ablation and plasma synthesis techniques. Microbial synthesis of nanoparticles.

Unit-III **Hours: 10**

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 **Hours: 10**

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

Unit-V **Hours: 10**

Nanomaterials in diagnosis-Imaging, nanosensors in detection of pathogens. Treatment of surface water, ground water and wastewater 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 & Sons, Ltd.
2. Leggett G. J., Jones R. A. L. (2005). Bionanotechnology. In Nanoscale Science and Technology. John Wiley & Sons, Ltd.
3.Mohan Kumar G. (2016). Nanotechnology: Nanomaterials and nanodevices. Narosa Publishing House.

Suggested Reading:

1. Goodsell D. S. (2004). Bionanotechnology. John Wiley & Sons, Inc.
2. Pradeep T. (2007). Nano: The Essentials-Understanding nanoscience and nanotechnology. Tata McGraw-Hill.
3. Nalwa H.S. (2005). Handbook of Nanostructured biomaterials and their applications in nanobiotechnology. American scientific publishers.
4. Editors of Scientific American. (2002). Understanding Nanotechnology. Grand central publishing.

References:

1. Niemeyer C.M. &Mirkin C.A. (2005). Nanobiotechnology. Wiley Interscience.
2.. Sharon, Madhuri and Maheshwar. (2012). Bio-Nanotechnology: concepts and applications. New Delhi, Ane books Pvt Ltd.
3. Alain Nouailhat, (2008). An Introduction to Nanoscience and Nanotechnology, Wiley.

Online Resources:

1.https://www.gale.com/nanotechnology

Semester IV – Elective Paper
Microalgal technology

(Candidates admitted from the academic year 2022 – 2023)

Total Hours: 52 **Credits: 5**

Learning Objectives	
(i)	To gain knowledge in the field of microalgal biotechnology
(ii)	To know about different groups of algae
(iii)	To learn about various commercial applications of various algal products and their processes
(iv)	To understand the environmental benefits of microalgae
(v)	To acquire knowledge in the field of microalgae biofuel technology

CO No.	**Course Outcome** Upon completion of this course, students will be able to	**PSOs Addressed**	**CL**
CO1	Acquire knowledge in the field of microalgal technology.	PSO1, PSO2&PSO4	R, U
CO2	Demonstrate the general characteristics of microalgae and their cultivation systems	PSO1, PSO2& PSO6	U, Ap
CO3	Identify various commercial application aspects of microalgae in the fields of food, nutraceuticals, agriculture and environment	PSO1, PSO2, PSO4& PSO6	Ap, C
CO4	Analyze the prospects and significance of microalgal technology in comparison with other domains of biotechnology	PSO1, PSO2& PSO6	An, E
CO5	Compare and critically evaluate recent applied research in this domain	PSO2, PSO4 &PSO6	An, E
CO6	Develop interest and create career/pursue research in the field of microalgal biotechnology	PSO1, PSO2, PSO5&PSO6	C

Unit – I **Hours: 12**

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 **Hours: 10**

Cultivation of freshwater and marine microalgae – Growth media – Isolation and enumeration of microalgae – Laboratory cultivation and maintenance – Outdoor cultivation – Photobioreactors: construction, types and operation; raceway ponds – Heterotrophic and mixotrophic cultivation –Harvesting of microalgae biomass

Unit – III **Hours: 10**

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

Unit – IV **Hours: 10**

Microalgae in environmental applications – Phycoremediation – 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 **Hours: 10**

Microalgae as feedstock for production of biofuels – Carbon-neutral fuels - Lipid-rich algal strains: *Botryococcus braunii*– Drop-in fuels from algae: hydrocarbons and biodiesel – bioethanol, biomethane, biohydrogen and syngas from microalgae biomass – Biocrude synthesis from microalgae – Integrated biorefinery 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.Shekh A., Schenk P., Sarada R. (2021). Microalgal Biotechnology. Recent Advances, Market Potential and Sustainability. Royal Society of Chemistry.

Suggested Reading:

1.Prospects and Challenges in Algal Biotechnology. (2017). Edited by Tripathi B.N., Kumar D. Springer Singapore.
2.Becker E.W. (1993). Microalgae Biotechnology and Microbiology. Cambridge University Press.

References:

1.Andersen R.A. (2005). Algal culturing techniques. Academic Press, Elsevier.

2.Bux F. (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.

Online Resources:

1.https://www.classcentral.com/course/algae-10442

2.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

PROJECT WORK

(Candidates admitted from the academic year 2022 – 2023)

Total Hours: 91 **Credits: 6**

Learning Objectives	
(i)	To provide hands on training on microbiological techniques needed for research
(ii)	To help students acquire fundamental knowledge in research
(iii)	To transform theoretical concepts into practical research skills
(iv)	To enable the students to convert ideas to practice
(v)	To imbibe research culture among students

CO No.	**Course Outcome** Upon completion of this course, students will be able to	**PSOs Addressed**	**CL**
CO1	Identify the acquired practical skills and perform research in Microbiology and related disciplines	PSO1, PSO2, PSO3, PSO4, PSO5	U, Ap
CO2	Convert the established theoretical concepts to practical research skills	PSO1, PSO2 & PSO4	An & E
CO3	Solve life-oriented and global problems through research outputs that benefit the society	PSO2, PSO3, PSO4 & PSO6	E & C
CO4	Survey the literature thoroughly and select a relevant research problem	PSO2, PSO4, PSO5 & PSO6	An, E
CO5	Choose appropriate research design and test the hypothesis by data analysis and evaluation	PSO1, PSO2, PSO5 & PSO6	An, E & C
CO6	Prepare thesis, reports, manuscripts and presentations for dissemination of research	PSO1, PSO2, PSO5 & PSO6	Ap & C