SHRI DAVARA UNIVERSITY NAYA RAIPUR (C.G.)

MASTER OF SCIENCE IN MICROBIOLOGY

SINGLE EXIT POST GRADUATE PROGRAMME CURRICULUM PER NEW EDUCATION POLICY-2020

ONE YEAR POST GRADUATE PROGRAMME FOR FOUR YEAR GRADUATION,

TWO YEAR POST GRADUATE PROGRAMME FOR THREE YEAR GRADUATION,

(SINGLE EXIT AFTER 1ST YEAR TWO SEMESTERS FOR AWARD OF POST GRADUATE DIPLOMA IN CHHATTISGARH)

(EFFECTIVE FROM THE SESSION: 2024-25)

Program Outcomes

On completion of program students will be able to-

1.Get ability to apply the process of science by formulating hypotheses and design experiments based on the scientific method.

2.Analyze and interpret results from a variety of microbiological methods.

3.Use quantitative reasoning by using mathematical calculations and graphing skills to solve problems in microbiology.

4.Communicate and collaborate with other disciplines by effectively communicating the fundamental concepts of microbiology in written and oral format.

5.Identify credible scientific sources to interpret and evaluate the evidences

6.Understand the relationship between science and society by recognizing and discussing logical, scientific and ethical issues in microbiology.

7.Prepare and view specimens for examination using light microscopy.

8.Use pure culture and selective techniques to isolate microorganisms. Identify microorganisms (media-based, molecular and serological).

9.Estimate the number of microorganisms in a sample by suitable enumeration technique.

10.Use appropriate microbiological and molecular lab equipment and methods.

11.Practice safe microbiology, using appropriate protective, biosafety and emergency procedures.

12.Document and report on experimental protocols, results and conclusions.

13.Basic knowledge about microbiology, biophysical techniques, biochemistry, cell biology, molecular biology, cancer biology, metabolic disorders etc.

14.To create awareness to become conscious citizens with a sense of responsibility towards their surrounding irrespective of any man made differences

श्री Davara University
Established under Chhattisgarh Private Universities (Establishment and Operation) Act, 2005

Faculty of Science
Shri Davada University, Raipur
Master of Science in Microbiology
Semester-III
Examination Scheme
(Effective from the session: 2024-2025)

****Major Elective Course:**

S N	Course Code	Th/ Pr	Subject	Type of Course	Credit				Examination Scheme				Total Marks
					L	T	P	TC	Theory		Practical		
									EX	IN	EX	I N	
1	**MBSC301T**	Th	Microbiology IX: Medical Microbiology	Core	4	1	-	5	70	30	-	-	100
2	**MBSC302T**	Th	Microbiology X: Research Methodology and Biostatistics	Core	4	1	-	5	70	30	-	-	100
3	**MBSC303T**	Th	**Major Elective I: A/B****	Elective	4		-	5	70	30	-	-	100
4	**MBSC304T**	Th	**Major Elective II: C/D****	Elective	4	-1	-	5	70	30	-	-	100
5	**MBSC305P**	Pr	Lab course: V (Combining Microbiology IX and X)	Core	-	-	4	2	-	-	35	15	100
6	**MBSC306P**	Pr	Lab Course: VI (Combining Electives I and II)	Core	-	-	4	2	-	-	35	15	100
	Total contact hour/ week: 26			**Total Credit 24**					**Total Marks**				**600**

A. Environmental Microbiology & Wastewater Management
B. Microbial Genomics
C. Agriculture Microbiology
D. Food and Diary Microbiology
*** Students need to opt any one paper, separately for Major Elective I and II.
*** At least 5 students need to opt a particular paper to run the course.

Course Title	**Microbiology IX: Medical Microbiology**				
Course Code	**MBSC301T**				
Course Credits	**L**	**T**	**P**	**TC**	
	4	**1**	**-**	**5**	
Prerequisites	**Basic knowledge of Microbiology**				
Course objectives	• Develop understanding about immune system, antigen antibody interactions. • Gain theoretical knowledge of various diseased conditions generated due to interplay of immune system components.				
Course Contents	**UNIT I** Host-Pathogen Interaction: Distribution and significance of normal human microbial flora, accidental pathogens, oncogenic viruses. Study of following groups of microbial pathogens (Morphological characters, pathogenesis, diagnosis, epidemiology, prophylaxis and treatment) Bacterial- Enteric pathogens (E. coli, Shigella, Salmonella, Campylobacters, Vibrio), Pneumococci, **UNIT II** Pyogenic organisms (Staphylococcus, Streptococcus), Helicobacter pylori, Clostridium spp., Mycobacterium spp. Viral- HIV, , Dengue, Hepatitis, flu; Fungal-Candida, Aspergillus, Cryptococcus,Microsporum; Parasite- Plasmodium & Entamoeba. **UNIT III** Diagnostic Microbiology: General principles of diagnostic microbiology; Collection, transport and processing of clinical samples; Cultural, biochemical, serological and molecular methods for microbial typing; Physical, biochemical and microscopic examination of clinical samples (Blood, urine, stool etc) **UNIT IV** Isolation and identification of pathogens including E. coli, Salmonella spp., Klebsiella spp., Shigella spp., Staphylococcus, Streptococcus spp. from clinical samples (Blood, urine, stool, etc), Antimicrobial agents and mode of action, antimicrobial drug susceptibility testing, antimicrobial resistance, mechanisms of antimicrobial resistance. Epidemiology and Public Health: Epidemiological principles in prevention and control of diseases; Microbial typing methods, Endemic, epidemic, pandemic and sporadic diseases; Concepts of mortality/ morbidity rates, incidence and prevalence; Communicable and non-communicable diseases; Sources and				

	reservoirs of infection-biotic and abiotic; Modes of transmission of infections; Disease prevention and control measures; Emerging and re-emerging diseases: examples of model bacterial, viral, fungal, and parasite diseases
Course outcomes	• pond completion, students gained the knowledge of most common medically important organism and the infections they cause. • different approaches, techniques and tools used to identify pathogens and control them. • Diagnostic approaches for microbial pathogens • Developing efficient vaccines and new drugs
Text Books	1. 1.Jawetz, Melnick, & Adelberg's Medical Microbiology by Brooks GF, Butel JS, Morse SA, Melnick JL, Jawetz E, Adelberg EA . 23rd edition. Lange Publication. 2004. 2. Cellular Microbiology by Cossart P, Boquet P, Normark S, Rappuoli R eds. 2nd edition. American Society for Microbiology Press. 2005. 3. Bacterial Pathogenesis: A molecular approach by Salyers AA and Whitt DD eds. American Society for Microbiology Press, Washington, DC USA. 2002. 4. Pathogenomics: Genome analysis of pathogenic microbes by Hacker J and Dorbindt U. ed. Wiley- VCH. 2006. 5. Molecular Microbiology: Diagnostic Principles and Practice by Persing DH, Tenover FC, Versalovic J, Tang Y, Unger ER, Relman DA, White TJ eds. American Society for Microbiology Press, 2004.
Reference Books	1. Infectious Disease Epidemiology: Theory and Practice by Nelson KE, Williams CM, Graham NMH eds. An Aspen Publication. 2001. 2. Plant pathology by George N. Agrios: 4th ed., Academic press, New York, 1969. 3. Plant pathology by R.S. Mehrotra: Tata McGraw –Hill publishing company limited. New Delhi. 4. Bacterial plant pathology, cell and molecular aspects by David C. Sigee, Cambridge University Press, 1993. 5. Molecular plant pathology by M. Dickinson: BIOS Scientific Publishers, London, 2003.

Course Title	**Microbiology X: Research Methodology and Biostatistics**				
Course Code	**MBSC302T**				
Course Credits	**L**	**T**	**P**	**TC**	
	4	**1**	**-**	**5**	
Prerequisites	**Basic knowledge of biology and statistics.**				
Course objectives	• The course is aimed at imparting basic outline on different aspects of Biostatistics and Research. • Impart basic knowledge of statistics and tools used for several quantitative analysis in microbiology				
Course Contents	**UNIT- I** Elementary concepts in Statistics: Concepts of statistical population and sample from a population; qualitative and quantitative data; nominal, ordinal, ratio, interval data; cross sectional and time series data; discrete and continuous data. Collection and scrutiny of data: Primary data; designing a questionnaire and a schedule; secondary data and sources of secondary data. Presentation of data: Diagrammatic and graphical representation of data; frequency distributions and cumulative frequency, distributions; histogram, frequency polygon, stem and leaf chart and ogives. Descriptive statistics: Concepts of central tendency or location. **UNIT- II** Probability, frequency and classical definitions of probability. Axiomatic definition of probability; addition and Multiplication the orems; conditional probability and independence; Bayes' theorem. Discrete and continuous random variables. **UNIT-III** Research Design: Concept and Importance in Research – Features of a good research design – Exploratory Research Design – concept, types and uses, Descriptive Research Designs – concept, types and uses. Experimental Design: Concept of Independent & Dependent variables. **UNIT- IV** Sampling Distributions, distribution of sample mean from anormal population; chi-square distribution; F and t statistics, distributions (no derivations) and their applications. Chi-square test for goodness of fit, Analysis of Variance (ANOVA). Central Limit Theorem for i.i.d case (statement and examples only). Evaluation of probabilities from the binomial and Poisson distributions using central limit theorem. Interpretation of Data and Paper Writing – Layout of a Research Paper, Journals in Computer Science, Impact factor of Journals, When and where to publish ? Ethical issues related to publishing, Plagiarism and Self-Plagiarism. (10%) 9. Use of				

	Encyclopedias, Research Guides, Handbook etc., Academic Databases for Computer Science Discipline. (5%) 10. Use of tools / techniques for Research: methods to search required information effectively, Reference Management Software like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office, Software for detection of Plagiarism.
Course outcomes	• Students shall be fully equipped with knowledge on Biostats and basics of research and its various aspects. This will enable students to be compatible with the world of research and its importance. • Students are able to predict the significance of the biological phenomenon on the basis of available data set.
Text books	1. A Text book of Biostatistics, by A.K.Sharma, Discovery publishing house 2. Introduction to Biostatistics, By Dr. Pranab Kumar Banerjee, S. Chand Publishers
Reference books	1. Research Methodology – C.R.Kothari

Course Title	**Major Elective I: A Environmental Microbiology & Wastewater Management**				
Course Code	**MBSC303T**				
Course Credits	**L**	**T**	**P**	**TC**	
	4	**1**	**-**	**5**	
Prerequisites	**Basic knowledge of microbiology and environmental studies.**				
Course Objectives	To provide students a basic understanding of environmental microbiology including; microbial diversity in the environment in relation to environment and agricultural welfare, ecosystem wellness, microbial interactions with pollutants in the soil and environment and the fate of microbial pathogens in the environment and agricultural fields. • Topics covered in detail include soil microbiology, aquatic microbiology, aero microbiology, biofertilizers and pesticides, microbial waste recycling and bioremediation etc. • These topics were elaborated to students with their theoretical and practical use. • The students will develop set of skills to recognise the ecological problems and critical evaluation of the human impacts on pollution, climate changes and as well as environmental protection. • Learning the basic principles of environment microbiology and be able to apply these principles to understanding and solving problems in current environmental and agricultural issues.				
Course Contents	**UNIT I** **Soil Microbiology: I** Classification of soil - physical and chemical characteristics, soil as a habitat for micro-organisms, microflora of various soil types, rhizosphere and rhizoplane. Nitrogen fixation: a symbiotic and symbiotic nitrogen fixation systems, root nodulation, symbiotic bacteria (process of root nodule formation), leghaemoglobin, nitrification and ammonification. **UNIT II** **Soil Microbiology: II** Microbial interactions: Symbiosis, mutualism, commensalism, mentalism, competition, antibiosis, actinorhiza, mycorrhizal fungi and its effect on plants. Aquatic Microbiology: Water ecosystems (fresh water, pond, lakes), marine habitats (estuaries, deep sea, hydrothermal vents), eutrophication, cyanobacterial and microalgal blooms: ecological implications and human health, toxins produced by cyanobacteria and other microalgae.; Extreme environments and extremophilic microbes: Habitats, diversity, adaptations and potential applications. **UNIT III**				

	Aero-microbiology -I droplet nuclei, aerosol, assessment of air quality, brief account of air- borne microbes – bacteria, fungi, and viruses, their diseases and preventive measures, phylloplane and phyllo sphere microflora, global warming and climate change. 31,Bio-fertilizers and Biopesticides in agriculture: **UNIT IV** **Aero-microbiology -II** Principles of crop inoculation with microbial agents, microbial inoculants and production, carriers for inoculants: types and characteristics, strain selection of bacteria, cyanobacteria and microalgae for biofertilizer production, phosphate solubilising microorganisms, AM fungi, plant growth promoting rhizobacteria, (PGPR), biocontrol agents. Bacterial and mucopeptides.
Course Outcomes	• Students will get the basic knowledge how to prepare and perform sampling and microbial analyses to determine the abundance, growth rate and microbial comm UNITy composition together with the basic environmental parameters. • Describe role of microorganism in recycling soil nutrients, biodegradation of complex plant polymers, sustaining and improving plant growth through improving nutrient availability, production of plant growth promoting substances and inhibiting pathogens. • Critically discuss the need for environmental microbiology and agricultural microbiology and explain their limitations. • Clarify application of microorganisms in varied fields of agricultural and environmental microbiology like bioremediation, biofertilizers and waste water treatment. • Analyse various aspects of N2 fixation, Phosphate solubilization, PGPR, biodegradation and bioremediation mechanisms provided by microbes.
Text Books	1. Subba Rao NS (1995). Soil Microbiology, Oxford & IBH Publishing Co. Pvt. Ltd, 4th edition. 2. Rangaswami G, Bhagyaraj DJ (2001). Agricultural Microbiology, Prentice Hall of India, New Delhi, 2nd edition. 3. Dubey RC, Maheswari DK (1999). Textbook of Microbiology, S. Chand & Co. 4. Evans GM, Furlong JC (2011). 4. Environmental Biotechnology- Theroy and application. Wiley-Blackwell.
Reference Books	1. Maier RM, Pepper IL, Gerba CP (2009). Environmental microbiology, Elsevier. 2. Osborn AM, Smith CCJ (2005). Molecular microbial ecology, Taylor & Francis US. 3. Ljungdahl LG, Adams MW, Barton LL, Ferry JG, Johnson MK (2003). Biochemistry and Physiology of Anaerobic Bacteria, Springer. 8. Madigan MT, Martinko JM, Dunlap PV, Clark DP (2012). 4. Brock Biology of Microorganisms, Prentice Hall, USA. 5. Environmental Biotechnology: Principles and Applications by Bruce E Rittmann and Perry L McCarty, McGraw-Hill International editions

Course Title	**Major Elective I: B Microbial Genomics**				
Course Code	**MBSC303T**				
Course Credits	**L**	**T**	**P**	**TC**	
	4	**1**	**-**	**5**	
Prerequisites	Basic knowledge of microorganisms				
Course Objectives	• This course aims to understand advancement of Microorganisms using culture-independent approaches.				
Course Contents	**UNIT I** **Taxonomy and phylogeny:** Basic concepts in systematics, taxonomy and phylogeny; Polyphasic taxonomy, molecular evolution; nature of data used in Taxonomy and Phylogeny, Definition and description of phylogenetic trees and various types of trees, Phylogenetic analysis algorithms such as maximum Parsimony, UPGMA, transformed distance, Bayesian algorithm, Neighbour- Joining. **UNIT-II** **Whole genome library**: Need of genome library, methodology, Enzymes used in genome library construction, Vectors for library construction, Genomic libraries in high-capacity vectors, cDNA cloning, Shotgun cloning, Whole genome shotgun sequencing: DNA sequencing theory pair end sequencing, Contributions of Craig Venter, Early history of genome sequencing. Hierarchical Shotgun sequencing, ePCR, Next-generation sequencing methods and full genome sequencing platforms. **UNIT- III** **Genome projects:** An overview of genome projects: human, plant, animal and microbial genomes. Genomes of model organisms – *Haemophilus, E. coli, Saccharomyces cerevisiae, Streptomyces* (industrial strain), virus and cyanobacteria. Functional analysis of genomes - microarrays and transcriptomes, gene chips and gene expression analysis, methods in proteomics and metabolomics. **UNIT- IV** **Structural and functional genomics**- definition, historical prospective and strategies. Genome Structure: genome sizes – microbial and organelle genome – genome physical mapping and sequencing – tools in genome analysis; Structural and functional annotations of 45 genes and genomes. Human Genome Map repositories. Evolutionary genomics – Comparative genomics. **Synthetic biology and bioengineering :**Introduction to synthetic biology - Metabolomics and synthetic microbiology, predictive model building (metabolomes) - Secondary metabolism and synthetic biology - synthetic bacterium, Mycoplasma				

	laboratories, Repressilators, Biobrics, iGEM, Genome engineering, yeast cell factories (artimisinin).
Course outcomes	• Students can understand about microorganism's phylogeny and genetics after completion of syllabus.
Text books	1. Sandy B. Primrose, Richard Twyman (2004), Genomics : Applications in Human Biology. Wiley and Sons. 2. Diana Marco (2011). Metagenomics: Current Innovations and Future Trends. Book: 978-1-904455-87-5. Horizon Scientific Press.
Reference books	1. Muhammad Jamal (2017). The CRISPR/Cas System: Emerging Technology and Application. Caister Academic Press. 2. Manuel Fuentes, Joshua LaBaer (2014). Proteomics: Targeted Technology, Innovations and Applications. Book: 978-1-908230-46-1. ebook: 978-1-908230-62-1. Caister Academic Press. 3. Patrick Arbuthnot and Marc S. Weinberg (2014). Applied RNAi: From Fundamental Research to Therapeutic Applications. Book: 978-1-908230-43-0. ebook: 978-1-908230-67. Caister Academic Press. 4. Jianping Xu (2014). Next-generation Sequencing: Current Technologies and Applications. Edited by: Published: 2014 Book: 978-1-908230-33-1. Ebook: 978-1-908230-95-9. Caister Academic Press. 5. S. B. Primrose (2002). Principles of Genome Analysis. A Guide to Mapping and Sequencing DNA from Different Organisms. Blackwell publishing. 6. Mount D (2004). Bioinformatics: Sequence and Genome Analysis by. Cold Spring Harbor Laboratory Press, New York. 7. Andreas D. Baxevanis, B. F. Francis Ouellette (2005). Bioinformatics- a practical guide to the analysis of Genes and Proteins. John Wiley & Sons, UK.

Course Title	**Major Elective II: C Agriculture Microbiology**				
Course Code	**MBSC304T**				
Course Credits	**L**	**T**	**P**	**TC**	
	4	**1**	**-**	**5**	
Prerequisites	**Basic knowledge of Microbiology & agriculture biology.**				
Course Objectives	• Student's knowledge increases in soil and environment related microorganisms.				
Course Contents	**UNIT I** **Microbes in the Terrestrial Environment –** General characteristics of porous media, Distribution of microbes in different soil zones and their metabolic states, role of microbes in surface soil formation, nutrients cycling, Soil pathogens and diseases in plant and human. **UNIT II** **Microbial Metabolism -** Conversion of light energy into chemical bond energy- Photosystems I & II. Production of ATP Cyano-bacteria and green algae. Role of bacterio-chlorophyll phycocyanin, phycoerythrin and carotenoids in photosynthetic bacteria and cholorphylls in green algae. Photosynthesis in anaerobic and sulphur bacteria. Biological N2-fixation by Free living anaerobic (Clostridium), facultatively anaerobic (Azospirillum) and aerobic (Azotobacter), N2-fixers associated with stem, root and leaf, Symbiotic N2-fixation in legumes and non- legumes by Rhizobium and Frankia, N2-fixation by cyanobateria. Requirement of ATP, O2-sensitivity and inhibition by ammonia and nitrogenous substance in the case of nitrogenase, The peculiarity of alternate nitrogenase of Streptomyces thermoautotrophicus, **Brief account of microbial interactions** -Symbiosis**,** neutralism, Commensalism, Competition, Ammensalism, Synergism, Parasitism. **UNIT III** **Biofertilizers-** Biological Nitrogen fixation- symbiotic and asymbiotic, mass production by Rhizobium, Azotobacter and Cyanobacteria, nitrifying ammonifying and photosynthetic bacteria, Denitrification of nitrate fertilizers to N2 and N2O (a green house gas) by denitrifying bacteria, free living and in association with Azolla, Phosphate solubilizing bacteria. Soil anerobic methanogens in rice field, Effect of soil pH and heavy metals on microorganisms, Microbial antagonism in soil, Biological control of soil-borne microbial pathogens **UNIT IV** **Application of Recombinant Microorganisms in Agriculture-**Agrobacterium and virus mediated gene transfer and improvements of crops **Microorganisms and Agriculture –** Functions of Microorganisms: Putrefaction, Fermentation, and				

	Synthesis, Relationships Between Putrefaction, Fermentation, and Synthesis of biomolecules, Classification of Soils Based on the Functions of Microorganisms (Disease-Inducing Soils, Disease-Suppressive Soils, Zymogenic Soils, Synthetic Soils), Controlling the Soil Microflora for Optimum Crop Production and Protection. **Eco-friendly Microbes and their utilisation** –Utilization of beneficial Microorganisms in Agriculture, Ice minus bacteria and microbial pesticides
Course Outcomes	• After completion of syllabus students knows about microorganisms related to soil microbiology.
Text Books	1. 1.Adams M. R. and Moss M. O. (1996). Food Microbiology, New Age International (Rt) Ltd., New Delhi. 2. Frazier W.C. and Westhoff D.C. (1995). Food Microbiology, Tata McGraw Hill Publishing Ltd., New Delhi. 3. Jay J. M., Loessner M. J. and Golden D. A. (2005). Modern Food Microbiology, Seventh edition. 4. Verma L. K. and Joshi V. K. (2000). Post Harvest Technology of Fruits and Vegetables, Tata McGraw Hill Publication. 5. Doyle M. P. and Beuchat L. R. (2007). Food Microbiology- Fundamentals and Frontiers, ASM Press. 6. Bhunia A. K. (2008). Food-borne Microbial Pathogens- Mechanisms and Pathogenesis, Food Science text Series, Springer International, New York, USA.
Reference Books	1. 1.Benwart G. J. (1987). Basic Food Microbiology, CBS Publishers & Distributors, New Delhi. 2. Deak T. and Beuchat L. R. (1996). Hand Book of Food Spoilage Yeasts, CRC Press, New York. 3. Garbutt J. (1997). Essentials of Food Microbiology, Armold – International Students edition, London. 4. Marriott N. G. and Gravani R. B. (2006). Principles of Food Sanitation, Food Science text Series, Springer International, New York, USA

Course Title	**Major Elective II: D Food & Dairy Microbiology**

Course Code	**MBSC304T**				
Course Credits	**L**	**T**	**P**	**TC**	
	4	**1**	**-**	**5**	
Prerequisites	**Basic knowledge of microbiology**				
Course Objectives	The aim of this course is to highlight the importance of food and the risks associated with consumption of foods due to microbial contamination.				
Course Contents	**UNIT- I** **Historical Perspective and Scope of Microbiology in relation to food-** Importance and significance of microorganisms in food. Factors – Intrinsic and Extrinsic parameters - affecting the growth of microorganisms in food. Food borne diseases- Bacterial food borne diseases- (Staphylococcal in toxification, Botulism, Salmonellosis, Shigellosis, EPEC Diarrhoea, *Clostridium perfringens* gastroenteritis, *Bacillus cereus* gastroenteritis; Food-borne fungi- Mycotoxins- Aflatoxicosis, Deoxynivalenol, Mycotoxicosis, Ergotism. Food Borne Viral Pathogens- (Norwalk virus, Reovirus, Rotavirus, Adenovirus, Parvovirus, Hepatitis A Virus) Food Borne Animal Parasites- Protozoa – Giardiasis, Amebiasis, Toxoplasmosis, Cryptosporidiosis. Cysticercosis/ Taeniasis; Roundworm – Trichinosis, Anisakiasis. **UNIT- II** **Detection of foodborne pathogens-** Detection and Enumeration of microorganisms and their products in food- Culture dependent methods- Sample collection and processing, analysis, surface testing, Direct microscopic observation, enumeration and isolation methods; Animal and Cell Culture Models to study food-borne pathogen interaction; Culture independent techniques – Metagenomics, Biosensor based detection of food pathogens, Nucleic-acid based methods- PCR; Immunological methods to detect food-borne pathogens; Molecular Typing and Differentiation of Food-borne Bacterial Pathogens. **UNIT- III** **Food spoilage and Food preservation-** Organisms involved, characteristic features, dynamics and significance of spoilage of different groups of foods - Cereal and cereal products, vegetables and fruits, meat, poultry and sea foods, milk and milk products, packed and canned foods. Spoilage and defects of fermented foods. Food preservation- High temperature, Low temperature- Significance of psychrophilic microbes in cold-stored and frozen foods, Drying, Chemical, Modified atmosphere, Radiation, other food protection methods and Microbial Resistance. 38 **UNIT- IV** **Microbiology of Food fermentations-** Milk Fermentation, Fermented and Non-fermented Dairy Products. Food fermentations- Manufacture of fermented foods- Meat and fishery products, plant products- Sauerkraut and fermented olives, breads,				

	beverages. Microbial cells as food- SCP, mushroom cultivation. Probiotics and their advantages, Genetically modified foods. **Food safety and Quality Management Systems-** General principles of food safety risk management, Recent concerns on food safety- Safe food alternatives (Organic foods), Good agricultural Practices (GAP), Food Indicators of water and food safety and quality- Microbiological criteria of foods and their Significance. The HACCP and ISO systems for food safety
Course Outcomes	• The Food Microbiology paper would enable students to learn about the epidemiology of food-borne diseases and the pathogens. Also, the study would equip them to study various methods of pathogen detection available along with understanding the beneficial and harmful effects of microbes in the food industry. Food Safety standards are also highlighted.
Text Books	1. Adams M. R. and Moss M. O. (1996). Food Microbiology, New Age International (Rt) Ltd., New Delhi. 2. Frazier W.C. and Westhoff D.C. (1995). Food Microbiology, Tata McGraw Hill Publishing Ltd., New Delhi. 3. Jay J. M., Loessner M. J. and Golden D. A. (2005). Modern Food Microbiology, Seventh edition. 4. Verma L. K. and Joshi V. K. (2000). Post Harvest Technology of Fruits and Vegetables, Tata McGraw Hill Publication. 5. Doyle M. P. and Beuchat L. R. (2007). Food Microbiology- Fundamentals and Frontiers, ASM Press. 6. Bhunia A. K. (2008). Food-borne Microbial Pathogens- Mechanisms and Pathogenesis, Food Science text Series, Springer International, New York, USA.
Reference Books	1. Benwart G. J. (1987). Basic Food Microbiology, CBS Publishers & Distributors, New Delhi. 2. Deak T. and Beuchat L. R. (1996). Hand Book of Food Spoilage Yeasts, CRC Press, New York. 3. Garbutt J. (1997). Essentials of Food Microbiology, Armold – International Students edition, London. 4. Marriott N. G. and Gravani R. B. (2006). Principles of Food Sanitation, Food Science text Series, Springer International, New York, USA

Course Title	**Lab course: V (Combining Microbiology IX (Medical Microbiology) and X (Research methodology & biostatistics)**

Course Code	**MBSC305P**				
Course Credits	**L**	**T**	**P**	**TC**	
	-	**-**	**4**	**2**	
Prerequisites	**Basic knowledge of theory paper.**				
Course Objectives	• Students gain practical knowledge of microorganism related to medical				
Course Contents	1. .Study of normal micro-biota of mouth; isolation, identification and preservation of microorganisms 2. Study of normal micro-biota of skin; isolation identification and preservation of microorganisms 3. Identification and Biochemical tests of respiratory tract bacterial pathogen (using avirulent strain of MTCC Culture of – Streptococci/ Klebsiella pneumoniae. 4. Identification and Biochemical tests of gastrointestinal bacterial infection (using avirulent strain of MTCC Culture of) – Salmonella / Shigella sps. 5. Laboratory examination and identification and biochemical tests of pus specimens (using avirulent strain of MTCC Culture) for Staphylococcus aureus, Streptococcus pyogenes and Pseudomonas aeruginosa. 6. Laboratory examination and identification and biochemical tests of urine specimens (using avirulent strain of MTCC Culture) for E.coli and Candida albicans. 7. Laboratory examination of sputum: Collection of sputum. Microbiological examination of sputum for pus cells and predominant bacteria. Ziehl-Neelsen staining to detect the presence of Mycobacterium. (using avirulent strain of MTCC Culture). 8. Visit to Clinical laboratory for one day orientation and demonstration on clinical specimen collection and processing. 9. .Representation of Statistical data by a) Histograms b) Ogive Curves c) Pie diagrams 10. Determination of Statistical averages/ central tendencies. a) Arithmetic mean b) Median c) Mode 11. Determination of measures of Dispersion a) Mean deviation b) b) Standard deviation and coefficient of variation c) Quartile deviation 12. Tests of Significance-Application of following				

	13. a) Chi- Square test b) t- test c) Standard error
Course Outcomes	• After completion of practical knowledge students very well know about microorganism related to medical issues,their isolation and identification
Text Books	1. Statistics in biology, Vol. 1 by Bliss, C.I.K. (1967) Mc Graw Hill, NewYork. 2. Practical Statistics for experimental biologist by Wardlaw, A.C. (1985). 3. Biotechnology: Food Fermentation Microbiology, Biochemistry and Technology. Volume 2 by Joshi.
Reference Books	1. Fundamentals of Dairy Microbiology by Prajapati. 2. Essentials of Food Microbiology. Edited by John Garbult. Arnold International Students Edition

Course Title	**Lab Course: VI (Combining Electives I and II)**
Course Code	**MBSC306P**

Course Credits	**L**	**T**	**P**	**TC**	
	-	**-**	**4**	**2**	
Prerequisites	**Basic knowledge of theory paper.**				
Course Objectives	Students can understand theory on the basis of practical's.				
Course Contents	**A. Environmental Microbiology & Wastewater Management** 1. Physical analysis of sewage/industrial effluent by measuring total solids, total dissolved solids and total suspended solids. 2. Determination of indices of pollution by measuring BOD/COD of different effluents. 3. Bacterial reduction of nitrate from ground waters 4. Isolation and purification of degradative plasmid of microbes growing in polluted environments. 5. Recovery of toxic metal ions of an industrial effluent by immobilized cells. 6. Utilization of microbial consortium for the treatment of solid waste [Muncipal Solid Waste]. 7. Biotransformation of toxic chromium (+ 6) into non-toxic (+ 3) by Pseudomonas species. 8. Tests for the microbial degradation products of aromatic hydrocarbons /aromatic compounds 9. Reduction of distillery spent wash (or any other industrial effluent) BOD by bacterial cultures. 10. Microbial dye decolourization/adsorption. **B. Microbial Genomics** **1.**Polymerase chain reaction-Gradient 2. Cloning of GFP protein 3. RT-PCR 4. 16S typing 5. Primary databases : Nucleic Acid & Protein : Genbank, EMBL, DDBJ 6. Multiple sequence alignment- Global and local alignment 7. Molecular Phylogenetic methods- Parsimony, Distance, Molecular Phylogeny, Bayesian - MEGA 8. Evaluation of Methods and Phylogenetic tree- Bootstrapping 9. Using Phylogenetic Trees to Study Speciation and Extinction, Gene duplication, Recombination 10. Comparative genomic analysis tools				

	11. Bioinformatic programs to protein mutations. **C. Agriculture Microbiology** Cultivation of microbes in nitrate broth from different environmental samples 2. Characterizing the morphology of the consortium 3. Testing the ability of nitrate removal by the consortium. 4. Testing the ability of phosphate accumulation by the consortium 5. Application of the consortium for germination trials for Mung bean in soil free medium. 6. Application of the consortium for germination trials for Mung bean in soil. 7. Testing the consortium for production of phytohormones. 8. Testing the plants growth in terms shoot length, leaf number, leaf dimension, number of nodes, chlorophyll content, number of nodules, root branching, etc. 9. The effect of PGPB on leaf epiphytic microbial consortia would be test. **D. Food and Diary Microbiology** 1.Production and estimation of lactic acid by Lactobacillus Sp.Or Streptococcus Sp. 2. Extraction and estimation of diacetyl. 3. Sauerkraut fermentation 4. Isolation of food poisoning bacteria from contaminated foods, Dairy products 5. Extraction and detection of afla toxin for infected foods. 6. Preservation of potato/onion by UV radiation 7. Production of fermented milk by Lactobacillus acidophilus. 8. Rapid analytical techniques in food quality control using microbial Biosensors.
Course Outcomes	• After completion of practical students know about particular theory paper on practical base.
Text books	1. Bioremediation by Baker K.H. And Herson D.S. 1994.. MacGraw Hill Inc. N.Y. 2. Waste Water Engineering - Treatment, Disposal and Re-use by Metcalf and Eddy, Inc., Tata MacGraw Hill, New Delhi. 3. Food Microbiology. 2nd Edition By Adams 4. Basic Food Microbiology by Banwart George J. 5. Food Microbiology: Fundamentals and Frontiers by Dolle 6. Biotechnology: Food Fermentation Microbiology, Biochemistry and Technology. Volume 2 by Joshi.

Reference books	1. Pollution: Ecology and Biotreatment by Ec Eldowney, S. Hardman D.J. and Waite S. 1993. - Longman Scientific Technical. 2. Maria S. Poptsova (2014). Genome Analysis: Current Procedures and Applications. Book: 978-1-908230-29-4. ebook: 978-1-908230-68-3. Caister Academic 3. Fundamentals of Dairy Microbiology by Prajapati. 4. Essentials of Food Microbiology. Edited by John Garbult. Arnold International StudentsEdition. 5. Microbiology of Fermented Foods. Volume II and I. By Brian J. Wood.Elsiever AppliedScience Publication. 6. Microbiology of Foods by John C. Ayres. J. Orwin Mundt. William E. Sandinee. W. H.Freeman and Co. 7. Dairy Microbiology by Robinson. Volume II and I.