



गोंय विद्यापीठ

ताळगांव पठार

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(Accredited by NAAC)

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GU/Acad –PG/BoS -NEP/2023/102/8

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CIRCULAR

The University has decided to implement the UGC Curriculum and Credit Framework for the Undergraduate Programme (CCFUP) of **Bachelor of Science in Microbiology/Bachelor of Science in Microbiology (Honours)** under the National Education Policy (NEP) 2020 from the Academic Year 2023-2024 onwards.

The approved Syllabus of Semesters I and II of the **Bachelor of Science in Microbiology/Bachelor of Science in Microbiology (Honours)** Programme is attached.

Principals of Affiliated Colleges offering the **Bachelor of Science in Microbiology/Bachelor of Science in Microbiology (Honours)** Programme are requested to take note of the above and bring the contents of this Circular to the notice of all concerned.

(Ashwin Lawande)

Assistant Registrar – Academic-PG

To,

1. The Principals of Affiliated Colleges offering the Bachelor of Science in Microbiology /Bachelor of Science in Microbiology (Honours) Programme.

Copy to:

1. The Director, Directorate of Higher Education, Govt. of Goa
2. The Dean, School of Biological Sciences and Biotechnology, Goa University.
3. The Vice-Deans, School of Biological Sciences and Biotechnology, Goa University.
4. The Chairperson, BoS in Microbiology.
5. The Controller of Examinations, Goa University.
6. The Assistant Registrar, UG Examinations, Goa University.
7. Directorate of Internal Quality Assurance, Goa University for uploading the Syllabus on the University website.

Goa University
Programme Structure for Semester I to VIII Bachelor of Science in Microbiology

Semester	Major -Core	Minor	MC	AEC	SEC	I	D	VAC	Total Credits	Exit
I	MIC-100 Basics of Microbiology (4)(3T+1P)	MIC-111 Microbial Ecology and Environment (4)	MIC-131 Introduction to Microbial World (3)		MIC-141 Techniques in Microbiology - Staining and Microscopy (3) (1T+2P)				20	--
II			MIC-132 Microbiology in Everyday Life (3)		MIC-142 Techniques in Microbiology: Microbial Cultivation and Enumeration (3) (1T+2P)			20	MIC-161 Laboratory Skills in Microbiology (4)	
III	MIC-200 Microbial Biochemistry (4) MIC 201 Molecular Biology (4)	MIC-211 Environmental Microbiology (4)	MIC-231 Scope of Microbiology (3)		MIC-241 Dairy Microbiology (3) (1T+2P)				20	--
IV	MIC-202 Cell Biology (4) MIC-203 Microbial Physiology (4) MIC-204 Microbial Genetics (4) MIC-205 Basic Biostatistics (2)	MIC-221 Instrumentation in Microbiology (4)							20	MIC-162 Quality control and assurance in microbial processes and products (4)

V	MIC-300 Industrial Microbiology (4) MIC-301 Virology (4) MIC-302 Mycology and Protista (4) MIC-303 Introduction to Bioinformatics (2)	MIC-321 Medical Microbiology (4)				MIC-361 Internship (2)			20	
VI	MIC-304 Agricultural Microbiology (4) MIC-305 Immunology (4) MIC-306 Taxonomy and Systematics of Prokaryotes (4) MIC- 307 Project (4)	MIC- 322 Food Microbiology (4)							20	
VII*	MIC-400 Research Methodology (4) MIC-401 Haematology and Clinical Biochemistry (4) MIC-402 Genetic Engineering (4) MIC-403 Microbial Fermentation (4)	MIC-411 Waste Management and Bioremediation (4)							20	

	MIC-404 Extremophiles (4)									
VIII	MIC-405 Pharmaceutical Microbiology (4) MIC-406 Epidemiology and emerging Diseases (4) MIC-407 Bioethics and IPR in Microbiology (4) MIC-408 Marine Microbiology (4)	MIC-412 Nanotechnology (4)					MIC-461 Dissertation (12)		20	

* Students opting for Honours with Research shall have to undergo, MIC-400 Research Methodology (4) Course in Sem VII and along with any three other Major Courses. Students opting for Honours shall have to enroll for Major Courses MIC-401, MIC-402, MIC-403 and MIC-404 in Semester VII.

Name of the Programme: Bachelor of Science in Microbiology

Course Code: MIC-100 (Major course)

Title of the Course: BASICS OF MICROBIOLOGY

Number of Credits: Theory - 3, Practical - 1

Effective from Academic Year: 2023-24

Prerequisites	NIL	
Objectives	To acquaint students with basic concepts in microbiology – history, microbial diversity, microbial growth and its control	
Content		
1	Unit - 1	(15)
A	Introduction and history of microbiology: Historical developments in microbiology, Development of microbiology as a discipline, Spontaneous generation v/s biogenesis, Contributions of Leeuwenhoek, Pasteur, Koch, Lister, Fleming, Lister, Fleming, development of various microbiological techniques and the golden era of microbiology, Role of microorganisms in fermentation, Germ theory of disease, Development of the field of Soil microbiology, Contributions of Beijerinck, Winogradsky, Waksman, Establishment of fields of Medical Microbiology and Immunology through the work of Ehrlich, Metchnikoff, Jenner.	8
B	Microbial Diversity and classification: Discovery and General characteristics (Occurrence, mode of nutrition, morphology, reproduction) of different groups of microorganisms, Acellular : viruses, viroids, prions - definitions and examples Cellular: Prokarya (Archaea, Eubacteria), Eukarya (Algae, fungi, protozoa) Systems of classification: Binomial nomenclature, Classification schemes such as (Linnaeus, Haeckel, Whittaker and Woese)	7
2	Unit – 2	(15)
A	Prokaryotic cell structure and function: Structure of prokaryotic cell (archae and eubacteria), Cell size, shape and arrangement, Components of the cell: Glycocalyx, slime, capsule, flagella, endoflagella, fimbriae and pili; Cell-wall: Composition and detailed structure of Gram-positive and Gram-negative cell walls, lipopolysaccharide (LPS), Spheroplasts, protoplasts, L forms, Cell Membrane: Structure, function and chemical composition of bacterial cellular membrane, Differences in the cell wall and cell membrane of archaea, Cytoplasmic inclusions: Endospore, Reserve materials (glycogen granules, lipid granules, PHA, PHB, volutin and sulphur granules), Other inclusions: metachromatic granules, carboxysomes, gas vacuoles, magnetosomes	8
B	Eukaryotic cell structure and function: Comparison in cell structure of yeast and fungi, Comparison between plant and animal cells, Cell wall; Plasma membrane; Modification of plasma membrane and intracellular junctions; Cytoskeleton, Protoplasm Eukaryotic cell organelles: nucleus, endoplasmic reticulum, golgi apparatus and protein sorting and transport, mitochondria, chloroplast, Ribosome; Centriole, lysosomes, peroxisomes, endosome and microbodies	7
3	Unit 3	(15)
C	Microbial cultivation, isolation, pure culture and preservation: Microbial Cultivation (aerobes and anaerobic bacteria), General principles of preservation, Aerobes: enrichment, streaking, serial dilution and plating	8

	methods (surface spreading, pour plate), Anaerobes: modified media (thioglycolate, Robertson's cooked meat media), modified techniques (pour plate, roll tube technique, overlay with paraffin oil), modified glassware and instruments (Brewers plate, spray plate, candle jar, Brewers jar, Gas Pak Anaerobic Jar), Methods of preservation of pure cultures, Preservation of cultures in continuous metabolic state: period transfer, overlaying with mineral oil, storage in sterile soil, Preservation of cultures in suspended metabolic state: storage in silica gel, drying in vacuum, lyophilization, cryopreservation, Culture collection centres / culture banks and their role	
B	Microbial growth control: principle and applications: Definition of important terms: disinfection, sterilization, antiseptic, sanitizer, germicide. Physical methods of microbial control: Heat: dry heat (incineration, hot air oven), moist heat and pressure (autoclave) moist heat (pasteurisation), low temperature (freezing, refrigeration), filtration (depth filters, membrane filters, HEPA filters), desiccation, osmotic pressure (concept of hypotonicity, hypertonicity, isotonicity, mode of lysis - plasmolysis, plasmoptysis, surface tension (CTAB, SDS), ultrasonic waves (sonicator), radiation (non-ionising – UV, ionising –gamma Xrays) Chemical methods of microbial control: heavy metal (mercury), Halogens (chlorine), Alcohols (ethanol), Phenols (triclosan), Quaternary ammonium compounds, Aldehydes (glutaraldehyde), Dyes (gentian violet), Sterilizing gases (ethylene oxide)	7
4	Unit - 4 - Practical	(30)
1.	Microbiology Good Laboratory Practices (GLP) and Biosafety.	2
2.	Study of morphological characteristics of protozoans, fungi, and algae using permanent slides.	2
3.	Monochrome staining, Negative staining, Gram's staining, Lactophenol-cotton blue staining	4
4.	Staining of intracellular structure: endospore, metachromatic granules.	4
5.	Preparation of culture media for bacterial cultivation; synthetic media, complex media, Nutrient agar, MacConkey agar.	2
6.	Isolation of pure cultures of bacteria by streaking method.	4
7.	Determination of viable count by spread plate method and pour plate method.	4
8.	Sterilization using physical methods: dry heat (hot air oven), moist heat (autoclaving)	2
9.	Testing the efficacy of sterilization using chemical methods: Determination of phenol coefficient.	2
10.	Study of the structure of cell organelles through electron micrographs.	2
11.	Preservation of cultures by periodic transfer and overlaying with mineral oil.	2
Pedagogy:	Lectures/tutorials/assignments/Demonstration	
References/ Reading	Atlas RM, Principles of Microbiology. WM.T.Brown Publishers. (1997) Cappucino J and Sherman N, Microbiology: A Laboratory Manual. Pearson Education Limited. (2013) Cooper GM and Hausman RE, The Cell: A Molecular Approach. ASM Press and Sunderland, Washington, D.C., Sinauer Associates, MA. (2013) Madigan MT, Martinko JM, Dunlap PV and Clark DP, Brock Biology of Microorganisms. Pearson International Edition. (2009)	

	<p>Modi HA, Elementary Microbiology Vol I, Fundamentals of Microbiology. (2019)</p> <p>Pelczar MJ, Chan ECS and Krieg NR, Microbiology. McGraw Hill Book Company. (2002)</p> <p>Salle AJ, Fundamental Principles of Bacteriology. Tata McGraw-Hill Education. (1961)</p> <p>Schlegel HG, General Microbiology. Cambridge , University Press. (1993)</p> <p>Stanier RY, Ingraham JL, Wheelis ML, and Painter PR, General Microbiology. McMillan. (1992)</p> <p>Talaro KP, Foundation in Microbiology, McGraw-Hill Education. (2020)</p> <p>Tortora GJ, Funke BR and Case CL, Microbiology: An Introduction. Pearson Education. (2019)</p> <p>Wiley JM, Sherwood LM and Woolverton CJ, Prescott's Microbiology. McGrawHill International (2009)</p>	
<p>Course outcome</p>	<ul style="list-style-type: none"> ◆ Understand different types of microorganisms and apply the knowledge of different classification systems for grouping microorganism. ◆ Explain the cellular organisation of prokaryotic and eukaryotic cells. ◆ Apply the techniques for obtaining and preserving pure cultures of bacteria. ◆ Elaborate on physical and chemical methods of microbial control. 	

Name of the Programme: Undergraduate

Course Code: MIC-111 (Minor course)

Title of the Course: MICROBIAL ECOLOGY AND ENVIRONMENT

Number of Credits: Theory - 4

Effective from Academic Year: 2023-24

Prerequisites	NIL	
Objectives	To introduce the concepts of Ecology, microbial diversity in different environment. To develop competency in understanding role of microorganisms in biogeochemical cycles and microbial interactions.	
Content		
1	Unit - 1	(15)
A	Ecology: Definition and concept of ecology, econiche, Development of ecology as a science, its significance and the history. Development of microbial ecology and history. Scope of Ecology	5
B	Ecosystems – components of ecosystems, levels of organizations, trophic levels, food chains, food webs, ecological pyramids, and energetics. Role of microorganism in food chain.	5
C	Biogeochemical Aspects of Microbial Ecology: Role of microorganisms in biogeochemical processes - carbon, nitrogen, phosphorous. Microbial enzymes in biogeochemical processes.	5
2	Unit – 2	(15)
A	Microbes in their natural habitats; Aquatic, Terrestrial, Atmospheric, Extreme Environments. Metabolic diversity of microorganisms - Photoautotroph, photoheterotrophs, chemolithoautotrophs, chemolithoheterotrophs, heterotrophs	9
B	Ecological Succession and role of microbes: rocky land (barren land), Winogradsky column, biofouling.	4
C	Microbial biofilms in environment: Nature and significance, Microbial mat.	2
3	Unit - 3	(15)
A	Microbial Interactions: Symbiosis, synergism, neutralism, commensalism, mutualism, amensalism, competition, parasitism, predation.	3
B	Microbe Plant interaction: Symbiotic and non-symbiotic, introduction of biological nitrogen fixation, mycorrhizae.	4
C	Microbe - Animal interaction: Rumen micro biology: Microbes in ruminants, ant-fungus mutualism, nematophagus fungi and symbiotic luminescent bacteria.	4
D	Environmental pollution and microbes for pollution abatement.: Environmental pollutants, biomagnification, Eutrophication; Concept of BOD & COD. Microorganisms for pollution abatement.	4
4	Unit - 4	(15)
1.	Demonstration of Winogradky's column.	
2.	Microbial life in pond water under microscope.	
3.	Bacterial Bioluminescence in dark.	
4.	Microbial biofilm on surfaces/microbial mat.	
5.	Nitrate reduction test by microbes/phosphate solubilization.	
6.	Lichen in ecological succession of barren land.	
7.	Algal bloom in lake/ocean	
8.	Root nodule in legumes and nodule forming bacteria.	

9.	Microbes growing on potato slices and bread.	
10.	Biocorrosion/Biodeterioration due to microorganisms.	
11.	Azolla-Anabaena Symbiosis.	
12.	Microbial antagonism.	
13.	Nostoc (photoautotroph)	
14.	Salinity/Dissolve oxygen	
15.	Trickling filter	
Pedagogy:	Lectures/tutorials/assignments/Demonstration	
References/ Reading	<p>Medigan, M. T., Bender, K. S., Bukley, D. H., Sattley, W. M., & Stahl, D. A. Brock Biology of Microorganisms. Pearson (2017).</p> <p>Mitchell, R. and Kirchman, D. L., Microbial Ecology of the Oceans, Wiley Publishers (2018).</p> <p>Munn, C., Marine Microbiology: Ecology and Applications, Garland Science, Taylor and Francis Group, N.Y (2020).</p> <p>Murugesan, A. G. and Rajakumari, C., Environmental Science and Biotechnology: Theory and Techniques, MJP Publishers (2019).</p> <p>Naik, M. and Dubey, S. K., Marine Pollution and Microbial Remediation, Springer Publications (2017).</p> <p>Satyanarayana, T., Johri, B. and Anil, T., Microorganisms in Environmental Management, Springer Publishers (2012).</p> <p>Sharma, P. D., Environmental Microbiology, Alpha Science International (2005).</p> <p>Willey, J. M., Sherwood, L. M., & Woolverton, C.J. Prescott's Microbiology. McGraw-hill Education (2016).</p>	
Course outcome	<ul style="list-style-type: none"> ◆ Understand the concept of Microbial Ecology and diversity. ◆ Analyze role of microorganisms and their enzymes in various biogeochemical processes. ◆ Interpret Microbial interactions. ◆ Apply microorganisms for pollution abatement. 	

Name of the Programme: Undergraduate

Multidisciplinary Course Code: MIC-131 (Multi-disciplinary course)

Title of the Course: INTRODUCTION TO MICROBIAL WORLD

Number of Credits: 3, Theory

Effective from Academic Year: 2023-24

Prerequisites	NIL	
Objective:	1. To provide a brief overview of microorganisms and study their diversity, classification, and distribution in the environment. 2. Explain the establishment of Microbiology as a science and study its significance.	
Content:		
1	UNIT 1	(15)
A	Discovery Era: The discovery of Microbial World and Microscope (Contributions of Anton von Leeuwenhoek and Robert Hooke)	2
B	Transition Era: The spontaneous generation controversy	1
C	Birth of Bacteriology, Medical Microbiology, and Virology due to the Contributions of the following scientists: Louis Pasteur (Fermentation, Pasteurization) Contribution of Robert Koch (Germ theory of disease, Tuberculosis, and Cholera, the concept of Pure culture), Ferdinand Cohn (Endospore discovery).	7
D	Contribution of Joseph Lister (antiseptic surgery), Paul Ehrlich (Chemotherapy), Alexander Fleming (Penicillin), Discovery of Streptomycin by Walksman.	5
2	UNIT 2	(15)
A	Establishment of Immunology: Vaccination, First Laboratory Vaccine, Story of Rabies vaccine, primary and secondary immune response, the contribution of Elie Metchnikoff (Phagocytosis).	3
B	Development of Soil Microbiology: Contribution of Martinus W. Beijerinck, Sergei N. Winogradsky.	2
C	Basic terminology in Microbiology, Position of Microorganisms in living world: Three domain classification	5
D	Major groups of Microorganisms: prokaryotes, eukaryotes, viruses; General morphology of bacteria, unicellular fungi, algae, and viruses.	5
3	UNIT 3	(15)
A	Distribution of Microorganisms in nature and their niches; classification of microorganisms based on environmental conditions.	5
B	Significance of Microbiology: Branches of Microbiology; Thrust areas of Microbiology: Genetic engineering and Biotechnology, pros and cons of microbiology.	5
C	Role of microorganisms in Public Health and Hygiene, microorganisms as health hazards, their role in diseases outbreaks and emerging infectious diseases	5
Pedagogy:	Lectures/tutorials/assignments	
References/ Readings	Alexander M. Introduction to Soil Microbiology. Krieger Publishing Company (1991).	
	Atlas R M, Principles of Microbiology, 2nd Edition, McGraw Hill education, Mumbai (2015).	

	Coyne M. Soil Microbiology. Cengage Learning, Inc. (1999).	
	Ingraham J L and Ingraham C A Introduction to Microbiology: A Case-History Study Approach, 3 rd edition, Thomson Brooks/Cole (2003).	
	Madigan MT, Martinko JM, Dunlap PV, and Clark DP. Brock Biology of Microorganisms. Pearson International Edition (2017).	
	Pelczar MJ, Chan ECS and Krieg NR. Microbiology. 5 th Edition, McGraw Hill Book Company, 5 (2001).	
	Tortora GJ, Funke BR and Case CL. Microbiology: An Introduction, 13 th edition. Addison-Wesley (2018).	
	Wiley JM, Sherwood LM and Woolverton CJ. Prescott's Microbiology, 10 th edition. McGraw Hill International (2016).	
Course Outcomes	<ul style="list-style-type: none"> ◆ Identify and describe important historical discoveries and developments in microbiology, including the work Louis Pasteur, and Antonie van Leeuwenhoek. ◆ Understand the diversity of microorganisms and their interaction with the environment. ◆ Develop scientific literacy and critical thinking skills by exploring, analysing, and interpreting scientific literature related to microbiology., ◆ Evaluate emerging topics and trends in microbiological research and create a report on their impact on science, society, and the global community. 	

Name of the Programme: Bachelor of Science in Microbiology

Course Code: MIC-141 (Skills enhancement Course)

Title of the Course: Techniques in Microbiology - Staining and Microscopy

Number of Credits: Theory - 1 , Practical - 2

Effective From AY: 2023-24

Prerequisites:	NIL	
Course Objectives:	To impart foundational microbiology laboratory techniques. To impart training in handling of light microscope. To recognize and describe bacterial cell morphology and cellular structure based on different staining techniques	
Content	Theory (1 Credit)	
1	UNIT 1 - Principles of Staining and Microscopy:	(15)
1.1	Stains: Principle of staining, Chromophore and Auxochrome groups, Different types of dyes: Acidic, Neutral, and Basic, Water and Fat soluble, Leuco, Fluorescent, and Compound dyes, Dyes used in selective media, and as pH indicators. Different methods of fixation, Fixatives, Mordants, Decolourisers. Types of staining techniques: Simple staining, Differential staining, and Specialized staining.	7
1.2	Microscopy: Parts of a light microscope; Lens systems: Condenser, Objective, and Occular; Magnification; Resolution. Use of microscope for determination of motility, and size of cells (Micrometry). Principle, working, and applications of: Bright field, Dark field, Phase contrast, Epifluorescence, Confocal, Electron Microscopy.	8
	Practical (2 Credits)	
2	UNIT -2 Simple Staining Techniques	(30)
2.1	1. Preparation of cell suspension aseptically, preparation and fixation of smears. 2. Monochrome staining using basic and acidic dyes (Negative staining).	5
2.2	Differential staining: 3. Gram staining method. 4. Acid-fast staining method.	5
2.3	Staining of cellular structures: 5. Capsule staining using Maneval's method. 6. Flagella staining using Leifson's method. 7. Cell wall staining using Chance's method. 8. Cell wall staining using Dayr's method. 9. Metachromatic granules staining Albert's method. 10. Lipid granules staining using Sudan Black B stain. 11. DNA staining using Feulgen method. 12. Endospore staining using Shaeffer and Fulton's method.	20
3	UNIT - 3 Specialized Staining Techniques	(30)
3.1	Staining of different types of cells 1. Spirochaetes staining 2. Lactophenol cotton blue staining of fungi. 3. Malarial parasite staining by Giemsa's method. 4. Staining of bacterial/algal cells using the fluorescent stains (DAPI and Acridine orange). 5. Blood staining using Leishman's and Geimsa's method.	16
3.2	Electron Microscopy	08

	6. Sample preparation for Scanning Electron Microscopy. 7. Study of microorganisms using Scanning Electron micrographs. 8. Transmission Electron Micrographs.	
3.3	9. Measurement of cell size using Micrometry. 10. Motility of cells using Hanging drop technique. 11. Preparation of permanent slides.	06
Pedagogy	Lectures/Practicals/Field Trips	
References/ Reading:	<p>Cappuccino, J.G. and Sherman, N. Microbiology: A Laboratory Manual. Pearson Education Limited, London. (2013)</p> <p>Gerhardt, P., R. G. E. Murray, R. N. Costilow, E. W. Nester, W. A. Wood, N. R. Krieg, and G. B. Phillips. Manual of methods for general microbiology. ASM Press, Washington, DC. (1981).</p> <p>Gerhardt, P., R. G. E. Murray, W. A. Wood, and N. R. Krieg. Methods for general and molecular bacteriology. ASM Press, Washington, DC. (1994).</p> <p>Leboffe, M. J., and B. E. Pierce. Microbiology: laboratory theory and applications. Morton Publishing Company, Englewood, CO. (2002).</p> <p>Nelson D.L. and Cox M.M. Lehninger Principles of Biochemistry, W.H. Freeman and Company. (2022)</p> <p>Norris J. R., Ribbons D. W. Wiley M.J., Methods in Microbiology. Volume 1. (1969)</p> <p>Sherwood L.M. and Woolverton C.J. Prescott, Harley and Klein's Microbiology, McGraw Hill. (2022)</p> <p>Wilson K. and Walker J. Principles and Techniques of Biochemistry and Molecular Biology. Cambridge University Press. (2018)</p>	
Course Outcomes:	<ul style="list-style-type: none"> ◆ Perform staining and microscopy. ◆ Operate different types of microscopes. ◆ Observe various types of cells and cellular structures using different microscopes. ◆ Analyse and interpret results of a range of staining techniques. 	

Name of the Programme: Undergraduate

Multidisciplinary Course Code: MIC-132 (Multi-disciplinary course)

Title of the Course: MICROBIOLOGY IN EVERYDAY LIFE

Number of Credits: 3, Theory

Effective from Academic Year: 2023-24

Prerequisites	NIL	
Objective:	<ol style="list-style-type: none">1. To gain knowledge about the occurrence of microorganisms in the environment.2. To study the role played by microbes in various aspects of human life.3. To compare and contrast between harmful and beneficial microorganisms in the world around us.4. To gain insight into the applications of microorganisms in various fields of human life.	
Content:		
1	UNIT 1	(15)
A	Microbiology In and Around us: Microflora of Air, Water, soil, and Human Body	5
B	Microbiology in the soil and agriculture: Examples of major types of beneficial and harmful microorganisms in soil for agriculture (Tabular form), Microorganisms as Bio-fertilizers (Nitrogen fixers, Phosphate solubilizers and Potassium mobilizers), Bio-pesticides – BT, <i>Trichoderma</i> and NPV with applications	10
2	UNIT 2	(15)
	Microbiology in Health and Medicine: Public health and microbes, Introductory Epidemiology, Definition and examples of Endemic, Epidemic and Pandemic, Hygiene and Communicable diseases, airborne, waterborne, foodborne and vectorborne in Tabular form; Antimicrobial Drugs – types, and applications; Antibiotics – Discovery, types, and functions; Vaccines – types, uses and schedules.	
3	UNIT 3	(15)
	Microbiology of fermented foods and beverages: Fermented Foods – Dosa, Soya sauce, Tempeh, Sauerkraut, Kimchi, Bread; Advantages and Health Benefits of Prebiotics, Probiotics, Synbiotics and Nutraceuticals Fermented dairy products: Yoghurt, butter and cheese. Fermented Beverages: Alcoholic- Beer and Wine; Nonalcoholic beverages- Kombucha; Vinegar;	
Pedagogy:	Lectures/tutorials/assignments	
References/ Readings	Ananthnarayanan, R and Jeyaram Panicker, C. K. Textbooks of Microbiology. Orient Longman. 17 th edition. (2010).	
	Madigan, M.T., Martinko, J.M., Dunlap, P.V. and Clark, D.P. . Brock Biology of Microorganisms, 12th edition, Pearson International edition, Pearson Benjamin Cummings. (2009)	
	Michael, J. Pelczar, Jr. E.C.S., Chan, Noel R. Krieg Microbiology Tata McGraw-Hill Publisher. (1998).	
	Willey, J.M., Sherwood L.M and Woolverton C.J., Prescott, Harley and Klein's. Microbiology. McGraw Hill Higher education. 9th Edition. (2013).	

Course Outcomes	<ul style="list-style-type: none">◆ Understand the occurrence of microorganisms in various aspects of daily life.◆ Recognize the role and importance of microorganisms.◆ Differentiate between harmful and beneficial microbes in various aspects of daily life◆ Connect microorganisms to their applications in agriculture, pharmaceutical, food, beverages, environment and medical fields.	
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Name of the Programme: Bachelor of Science in Microbiology

Course Code: MIC- 142 (Skills enhancement course)

Title of the Course: Techniques in Microbiology - Microbial Cultivation and Enumeration

Number of Credits: Theory - 1, Practical - 2

Effective From AY: 2023-24

Prerequisites:	NIL	
Course Objectives:	To equip the students with the skills and techniques required for the cultivation and enumeration of microorganisms	
Content	Theory (1 Credit)	
1	UNIT - 1 Microbial cultivation and enumeration	(15)
1.1	Composition and ingredients of media, Preparation and storage of media, Types of Media: Natural and synthetic, complex and chemically defined media, selective media, differential media, enriched and enrichment media, transport media. Measurement of pH, Buffers and buffering capacity. Sterilization of media using physical Methods: Heat (Autoclave, Pasteurization, Tyndallization), Filtration (Diatomaceous earth filters, membrane filters)	08
1.2	Direct and indirect methods of enumerations, Petroff-Hausser Counting Chamber, Membrane filtration technique, Flow cytometry, Coulter counters, Use of fluorescent dyes to determine viability	07
	Practical (2 Credits)	
2	UNIT - 2 Techniques for cultivation of microorganisms	30
2.1	Growth media, and inoculation 1. Preparation of Growth Media (solid and liquid): Complex and Synthetic, Differential, Selective, and Enriched 2. Study of aseptic techniques: plugging, transfer or pouring of media, preparation of slants and butts and inoculum 3. Isolation of bacteria from environmental samples (soil, water, food, etc.) 3.a. Sample collection and processing 3.b. Enrichment of cultures 3.c. Serial dilution technique 3.d. Pour plate and spread plate techniques 3.e. Streak Plate techniques: Parallel line, T-streak, Continuous, Radial, and Quadrant 3.f. Study of colony characteristics 4. Storage and maintenance of cultures	10
2.2	Cultivation of different types of microorganisms 1. Cultivation of microaerophilic bacteria 2. Cultivation of anaerobic bacteria using anaerobic jar 3. Cultivation of yeast and fungi 4. Cultivation of cyanobacteria 5. Cultivation of viruses/ bacteriophages	12
2.3	Growth curve of bacteria 1. Study of growth curve of bacteria (E. coli) by turbidimetric 2. Study of growth curve of bacteria (E. coli) by plate count method. 3. Calculation of generation time, and specific growth rate of bacteria.	08
3	UNIT - 3 Enumeration of Microorganisms	30
3.1	Direct microscopic methods of enumeration using	08

	<ol style="list-style-type: none"> 1. Breed's smear 2. Membrane filtration technique 3. Petroff-Hausser counting chamber 	
3.2	<p>Indirect methods of enumeration</p> <ol style="list-style-type: none"> 1. Measurement of optical density and turbidity 2. Standard Plate Count or Viable Count Technique 3. Most Probable Number 4. Measurement of cell mass (dry weight) 5. Chlorophyll determinations to measure phototrophic protist and cyanobacterial populations 6. Plaque assay for enumeration of viruses 	22
Pedagogy	Lectures/Practicals in laboratory/Field Trips	
References/ Reading:	<p>Cappuccino, J.G. and Sherman, N. Microbiology: A Laboratory Manual. Pearson Education Limited, London. (2013)</p> <p>Gerhardt, P., R. G. E. Murray, R. N. Costilow, E. W. Nester, W. A. Wood, N. R. Krieg, and G. B. Phillips. Manual of methods for general microbiology. ASM Press, Washington, DC. (1981).</p> <p>Gerhardt, P., R. G. E. Murray, W. A. Wood, and N. R. Krieg. Methods for general and molecular bacteriology. ASM Press, Washington, DC. (1994).</p> <p>Leboffe, M. J., and B. E. Pierce. Microbiology: laboratory theory and applications. Morton Publishing Company, Englewood, CO. (2002).</p> <p>Nelson D.L. and Cox M.M. Lehninger Principles of Biochemistry, W.H. Freeman and Company. (2022)</p> <p>Norris J. R., Ribbons D. W. Wiley M.J., Methods in Microbiology. Volume 1. (1969)</p> <p>Willey JM, Sherwood LM, and Woolverton CJ. Prescott's Microbiology. McGraw Hill Higher Education. (2022)</p> <p>Wilson K. and Walker J. Principles and Techniques of Biochemistry and Molecular Biology. Cambridge University Press. (2018)</p>	
Course Outcomes:	<ul style="list-style-type: none"> ◆ Demonstrate key concepts of microbial growth, cultivation, and enumeration ◆ Collect and process sample for microbial analysis. ◆ Prepare media for the cultivation of different types of microorganisms ◆ Process and analyze the samples for microbial detection and enumeration 	

Name of the Programme: Bachelor of Science in Microbiology

Course Code: MIC-161 (Exit Course)

Title of the Course: Laboratory Skills in Microbiology

Number of Credits: 4 - Theory - 2, Practical - 2

Effective From AY: 2023-24

Prerequisites:	NIL	
Course Objectives:	To equip the student with basic knowledge of microbiology laboratory work	
Content	Theory (1 Credit)	
1	Unit 1	(15)
A	Good laboratory practices, biosafety and laboratory waste management - GLP definition, guidelines, examples. Biosafety levels, guidelines. Lab waste management, guidelines for segregation & safe disposal, bioethics.	2
B	Laboratory solutions, reagents and media - Laboratory solutions - molar, normal, percent, saturated, standard. pH scale – acidic, basic solutions. Deionised water. Standardization, calibration of pH meter, weighing balance. Media composition Sabouraud's agar, Mac-Conkey's agar, blood agar, fermentation base. Dehydrated media. Quality control monitoring - incubator temperatures, media controls.	3
C	Sterilization, disinfection and aseptic techniques - Definition – sterilization, disinfection, decontamination. Dry heat and moist heat. Principle and working of autoclave, pressure cooker, hot air oven. Sterility checks. Aseptic transfer technique. Principle and working of LAF.	5
D	Maintenance of lab equipment and cultures - Principle, working and care of: microscope, colorimeter, micropipettes, spectrophotometer, centrifuge. Stock cultures, subcultures, maintenance.	5
2	Unit 2	(15)
A	Quality assessment of water, milk, food - Sample collection. Potability of water, MPN, confirmed, completed test. Dye reduction tests for milk, resazurin, methylene blue. Pasteurisation, test for efficiency. Spoilage of food, microorganisms involved in food spoilage. TDP, TDT.	5
B	Basic Haematology and Clinical biochemistry - Blood, plasma, serum – definition. ABO blood group system. Haemoglobin – determination, haemoglobinometer. Clinical aspects of regulation of blood sugar, diabetic profile. Clinical aspects of lipid profile.	5
C	Basics in molecular biology - DNA, RNA, protein. Structure and function. Estimation of DNA - diphenylamine, RNA- orcinol, protein- folin lowry. Separation – gel electrophoresis.	5
3	Unit 3 - Practical (2 Credits)	(60)
3.1	Good lab practice, hand sanitization, disinfection of working tables, proper cleaning and handling of glassware, proper storage of chemicals and media, maintenance of stock registers.	2
3.2	Preparation of stock solutions, percent, molar, normal. Preparation of buffers, use of pH meter. Calibration of weighing balance, ph meter. Preparation of stains- crystal violet, saffranin	4
3.3	Sterilisation of glassware using oven, autoclave, pressure cooker. Preparation of LAF for aseptic transfers microbial culture.	4

3.4	Preparation of media – Sabouraud’s agar, Mac Conkey’s agar, blood agar. Fermentation base – Lactose in PWB. Pouring of media - plates, slants, butts. Sterility tests. Culturing bacteria using T streak.	14
3.5	Cleaning of microscope lenses, cuvettes, handling and use of micropipettes. Preservation of cultures, stock cultures, subcultures.	4
3.6	Collection of water samples. Test for potability of water. Quality assessment of milk, resazurin, methylene blue, phosphatase test. Study of types of bacteria in spoiled food, TDP, TDT.	16
3.7	Collection and handling of blood. Detection of blood groups. Preparation of serum and plasma. Use of glucometer. Use of haemoglobinometer.	8
3.8	Estimation of DNA (diphenylamine method), RNA (Orcinol method), Protein (Folin Lowry). Casting of gel and Agarose gel electrophoresis.	8
Pedagogy	Lectures/Practicals in laboratory/group discussion/Field Trips	
References/ Reading:	Atlas RM. Principles of Microbiology. WM.T.Brown Publishers, (1996). Cappuccino, J.G. and Sherman, N. Microbiology: A Laboratory Manual. Pearson Education Limited, London. (2013) Gerhardt, P., R. G. E. Murray, R. N. Costilow, E. W. Nester, W. A. Wood, N. R. Krieg, and G. B. Phillips. Manual of methods for general microbiology. ASM Press, Washington, DC. (1981). Gerhardt, P., R. G. E. Murray, W. A. Wood, and N. R. Krieg. Methods for general and molecular bacteriology. ASM Press, Washington, DC. (1994). Leboffe, M. J., and B. E. Pierce. Microbiology: laboratory theory and applications. Morton Publishing Company, Englewood, CO. (2002). Modi H.A, A Handbook of Elementary Microbiology Vol I, Fundamentals of Microbiology, AKTA Prakashan, India, (1995) Norris J. R., Ribbons D. W. Wiley M.J., Methods in Microbiology. Volume 1. (1969) Sherwood L.M. and Woolverton C.J. Prescott, Harley and Klein’s Microbiology, McGraw Hill. (2022) Pelczar MJ, Chan ECS and Krieg NR. Microbiology. McGraw Hill Book Company. (2001) Salle A.J. Fundamental Principles of Bacteriology. Tata McGraw-Hill Education (1984) Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. General Microbiology. McMillan (1999) Wiley JM, Sherwood LM and Woolverton CJ. Prescott’s Microbiology. McGraw Hill International (2008)	
Course Outcomes:	<ul style="list-style-type: none"> ◆ Student will be able to assist in the conduct of microbiology experiments. ◆ Student will independently handle equipment regularly used in the microbiology lab. ◆ Student will be able to handle preparation of media/reagents and culture suspensions. ◆ Student will be equipped to perform basic haematology lab tests. 	