B. Sc. Microbiology Sem I and II

Name of Program	**B. Sc. Microbiology**
Abbreviation	**MB**
Duration	**3 Years**
Eligibility Criteria	**Basic science**
Objective of Program	To convey scientific and technological knowledge and information with modern age orientation. To help young learners and realize that science and technology, both hand in hand can enrich and develop a personality, thus promising a life of success and achievement.
Program Outcome	PO1: Students shall learn various aspects of microbiology such as bacteriology, virology, algology, microbial physiology, bacterial genetics, immunology, biochemistry, rDNA technology. PO2: Students shall gain knowledge of applied microbiology such as industrial microbiology, environmental microbiology, industrial microbiology, food and dairy microbiology. PO3: Students shall learn about the presence of microorganisms in air, water, soil and its role in developing a sustainable environment. PO4: Students shall acquire the awareness regarding the importance of microorganisms in plant, animal, human health and diseases. PO5: Students shall gain knowledge of microbial technology and its applications in in the production of industrially important microbial products. PO6: Students shall become aware of the role of microbes in the development of molecular biology and the advancements in genetic modifications technologies. PO7: Generate skilled manpower ready to use by industries in various sectors.
Program Specific Outcomes	Students will be able to appear and qualify for competitive exams like NET, GSET, and GATE. They will be skilled enough to join any research institute, Biopharma industry or even start ventures of their own. PSO1: Students will develop skill to observe, isolate, identify and cultivate microorganisms. PSO2: Students will acquire and demonstrate proficiency in good laboratory practices in microbiology laboratory. PSO3: Students will develop practical skills of tools and techniques used to study microbiology. PSO4:Students will develop oral and written communication skills, effective presentation skills and interpretation skill from observed results. PSO5: Students will be graduates in microbiology who shall

	understand the societal problems and play a vital role by providing microbial solutions. PSO6: Students will be able to build their careers in public and global health, environmental organizations, food, pharmaceuticals and fermentation industries.
Mapping between POs and PSOs	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
PO1	■		■		■	
PO2	■	■	■		■	
PO3		■	■	■		■
PO4		■	■	■		■
PO5		■	■		■	■
PO6	■	■	■	■	■	■
PO7		■	■	■	■	

Medium of Instruction	English
Program Structure	Semester I

Course Code	Title	Teaching per week		Course Credits	University Examination		Internal Marks	Total Marks
		Theory	Practical		Duration	Marks		
	Foundation Compulsory	2	-	2	2 Hrs	50	20	70
	Generic Elective	2	-	2	2 Hrs	50	20	70
	Core 1	4	4	6	2 +2 Hrs	50	20	70
	Core 2	4	4	6	2 +2 Hrs	50	20	70
	Core 3	4	4	6	2 +2 Hrs	50	20	70
	Foundation Elective	2	-	2	2 Hrs	50	20	70
	Total	18	12	24	18Hrs	300	120	420

Program Structure		Semester II						
Course Code	**Title**	**Teaching per week**		**Course Credits**	**University Examination**		**Internal Marks**	**Total Marks**
		Theory	**Practical**		**Duration**	**Marks**		
	Foundation Compulsory	2	-	2	2 Hrs	50	20	70
	Generic Elective	2	-	2	2 Hrs	50	20	70
	Core 1	4	4	6	2 +2 Hrs	50	20	70
	Core 2	4	4	6	2 +2 Hrs	50	20	70
	Core 3	4	4	6	2 +2 Hrs	50	20	70
	Foundation Elective	2	-	2	2 Hrs	50	20	70
	Total	18	12	24	18Hrs	300	120	420

<table>
<tr><td>Course Code</td><td>MB 101</td></tr>
<tr><td>Course Title</td><td>HISTORY AND SCOPE OF MICROBIOLOGY</td></tr>
<tr><td>Credit</td><td>2</td></tr>
<tr><td>Teaching per Week</td><td>4</td></tr>
<tr><td>Minimum weeks per Semester</td><td>15 (Including Classwork, examination, preparation, holidays etc.)</td></tr>
<tr><td>Effective From</td><td>June 2019</td></tr>
<tr><td>Purpose of Course</td><td>The main aspect of this paper is to study and understand the scope of microbiology with major groups of microorganisms, ancient history and discovery of microbial world. An aim of this paper is to present existing development of the microbiology in diversified area.</td></tr>
<tr><td>Course Objective</td><td>To understand the importance of microbiology and microorganisms in the living world.
To study the major groups of microorganisms
To gain an insight of discovery of microorganisms
To learn about the development of various branches of microbiology</td></tr>
<tr><td>Course Outcomes</td><td>CO1: Students will learn the multifaceted existence of microorganisms.
CO2: Students will gain knowledge about the major groups of microorganisms and its distribution.
CO3: Students will learn about the discovery of microbial world Students will know about the role of microorganisms in disease development
CO4: Students will gain awareness regarding the development of pure culture techniques, chemotherapy, agricultural microbiology, immunology and biotechnology.</td></tr>
<tr><td>Mapping between COs with PSOs</td><td>
<table>
<tr><td></td><td>PSO1</td><td>PSO2</td><td>PSO3</td><td>PSO4</td><td>PSO5</td><td>PSO6</td></tr>
<tr><td>CO1</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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<tr><td>Pre-requisite</td><td>Basic science</td></tr>
</table>

Course Content	**UNIT-1: SCOPE OF MICROBIOLOGY – I:** 1.1 An introduction to Microbiology 1.2 Microbiology: A multifaceted Science 1.3 Position of Microorganisms in living world 1.4 Taxonomic status of Viruses **UNIT-2: SCOPE OF MICROBIOLOGY- II:** 2.1 Major groups of Microorganisms 2.2 Distribution of Microorganisms in nature 2.3 Applied areas of Microbiology **UNIT-3: ANCIENT HISTORY OF MICROBIOLOGY:** 3.1 The discovery of Microbial World and Microscope 3.2 The spontaneous generation controversy 3.3 Discovery of microbial effects on organic matter 3.4 Discovery of the role of Microbes in causation of 3.5 Disease 3.6 History of Virology **UNIT-4: DEVELOPMENT IN MICROBIOLOGY:** 4.1 Development of pure culture techniques 4.2 Development of Foundation for immunology 4.3 Development of Agricultural microbiology 4.4 Development of Chemotherapy 4.5 Development of Modern immunology 4.6 Molecular Biology and Biotechnology
Reference Books	**REFERENCES:** 1. Modi. H. A. (2014) A Handbook of Elementary Microbiology, Shanti Prakashan, (ISBN: 978-93-5070-1010) **Further Reading:** 2. Pommerville J.C. (2014) Alcamo's Fundamental of Microbiology, 10th Edition, Jones &BarlettPvt. Ltd., (ISBN: 978-0-07-462320-6) 3. Medigan M., et al., (2015) Brock Biology of Microorganisms, 14th Edition, Pearson education Ltd., (ISBN: 978-1-292-01831-7)
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

<table>
<tr><td>Course Code</td><td>MB 102</td></tr>
<tr><td>Course Title</td><td>FUNDAMENTALS OF MICROSCOPY</td></tr>
<tr><td>Credit</td><td>2</td></tr>
<tr><td>Teaching per Week</td><td>2</td></tr>
<tr><td>Minimum weeks per Semester</td><td>15 (Including Classwork, examination, preparation, holidays etc.)</td></tr>
<tr><td>Effective From</td><td>June 2019</td></tr>
<tr><td>Purpose of Course</td><td>The main aspect of this paper is to study and understand the basic principle of microscopy. It focused on different type of fundamental and advanced microscopic techniques. Also provide knowledge related to different types of dyes, staining and staining theories of bacteria.</td></tr>
<tr><td>Course Objective</td><td>To understand the fundamentals of microscopy
To learn different types of light microscopy and its uses
To study electron microscopy, its types and advances in electron microscopy.
To learn basics of dyes and stains and the principle of staining microorganisms</td></tr>
<tr><td>Course Outcomes</td><td>CO1: Students will learn the relevance of resolving power, numerical aperture and lens aberrations in the working of microscopy. Students will understand the importance of ocular and condenser.

CO2:Students will understand the principle and working of light microscope.
Students will acquire knowledge of types of light microscopy

CO3: Students will learn electron microscopy
Students will become aware different types of electron microscopy and its applications

CO4: Students will gain understanding regarding dyes and stains Students will learn the theory and technique of staining bacteria.</td></tr>
<tr><td>Mapping between COs with PSOs</td><td>
<table>
<tr><th></th><th>PSO1</th><th>PSO2</th><th>PSO3</th><th>PSO4</th><th>PSO5</th><th>PSO6</th></tr>
<tr><td>CO1</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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<tr><td>CO4</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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<tr><td>Pre-requisite</td><td>Basic science</td></tr>
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Course Content	**UNIT-1: BASIC PRINCIPLE OF MICROSCOPY:** 1.1 General Principles of optics 1.2 Structure of light 1.3 Objectives – Numerical Aperture, Resolving power 1.4 Immersion objectives - Depth of focus, Equivalent focus, Working distance of uncovered objects & covered objects, Chromatic aberrations in objectives. 1.5 Oculars – Huygens, Compensating, Flat-field. 1.6 Condenser **UNIT-2: LIGHT MICROSCOPY:** 2.1 Bright field microscope 2.2 Dark field microscope 2.3 Phase contrast microscope 2.4 Differential Interference Contrast Microscope 2.5 Fluorescence microscope 2.6 Confocal microscopy **UNIT-3: ELECTRON MICROSCOPY:** 3.1 Transmission Electron microscope 3.2 Scanning Electron microscope 3.3 Electron cryotomography 3.4 Scanning probe microscopy 3.4.1 Scanning tunneling microscope 3.4.2 Atomic force microscope **UNIT-4:DYES& STAINS:** 4.1Dyes – Acidic & Basic dyes, Chromophore, Classification of biological stains 4.2 Staining solution – Intensifier, Mordants 4.3 Theories of staining 4.4 Staining of bacteria
Reference Books	**REFERENCES:** 1. Willey J.M., Sherwood L.M. and Woolverton C.J., (2017) Prescott's Microbiology, 10th Edition McGraw - Hill Education, , (ISBN: 978-981-3151-26-0) 2. Salle A. J., (1984) Fundamental Principles of Bacteriology, 7thEdition,Tata McGraw – Hill, (ISBN:0-07-099-562-1) **Further Reading:** Pelczar, Chan and Krieg, (2001), Microbiology-Concepts and Application, 5th Edition, McGraw-Hill, (ISBN: 9780074623206)
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

Course Code	**MBP-103**
Course Title	**Microbiology Practical**
Credit	2
Teaching per Week	4 Hrs
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	June 2020
Purpose of Course	To provide hand's on experience of using instruments in the laboratory for microbiology purpose.
Course Objective	Students will able to learn about basic working principles of microscope, various staining techniques and various instruments.
Course Outcomes	CO1-CO4: students will able to learn about basic instruments. CO5-CO7: Students will learn about concepts of pH meter as well as basic morphological structure of yeast/bacteria. CO8: Students will learn to prepare basic laboratory working solutions. CO9-CO12: Students will learn about basic staining techniques.
Mapping between COs with PSOs	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1						
CO2						
CO3						
CO4						
CO5						
CO6						
CO7						
CO8						
CO9						
CO10						
CO11						
CO12						

Pre-requisite	Basic science

Course Content	1. Study of bright field compound microscope: Components, use and care. 2. Microscopic examination of living microorganisms: (a) Observation of hay infusion by Wet Mount Technique. (b) Observation of bacterial Motility by Hanging Drop technique 3. Measurement of microorganisms (Micrometry) using Ocular and Stage Micrometer. 4. Introduction to common instruments/equipments in microbiology laboratory: Autoclave, Incubator, Hot air oven, Laminar air flow, Centrifuge, Bacteriological Filter, pH meter, Colorimeter, Anaerobic jar, Colony counter. 5. Observation of morphological characteristics of Yeast / Fungi / Protozoa by Dark Field and Phase Contrast Microscopy. 6. Preparation of Nutrient broth / agar medium and cultivation of bacteria. 7. pH measurement and adjustment using Lovibond / Hellige's comparator (Phenol red and Bromothymol blue disc). 8. Preparation of standard solutions: (c) Percent solutions (d) Part dilutions (e) Molar solutions (f) Normal solutions (g) Molal solutions (h) PPM and PPB solutions 9. Monochrome staining by Acidic and Basic dye. 10. Gram staining. 11. Acid fast staining. 12. Observation of spirochaete by negative staining.
Reference Books	1. Patel R.J. and Patel R.K. (2016) Experimental microbiology Volume I, 9th Edition.Aditya, 2. Patel R.J. and Patel R.K. (2017) Experimental microbiology Volume II, 9th Edition. Aditya, 3. Cappuccino J.G. (2016) Microbiology; A Laboratory Manual, 11th Edition. Pearson Edication (Singapore) Pvt. Ltd., (ISBN: 978-9332535190) 4. Aneja K.R. (2001) Experiments in Microbiology, Plant Pathology, Tissue culture and Mushroom production technology, 3rd Edition. New Age International Publishers, (ISBN: 978-9386418302)
Teaching Methodology	Class work, Discussion, Self-Study, Seminars and/or Assignment

Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

Semester 2 MB

Course Code	**MB 201**
Course Title	**PROKARYOTIC AND ARCHAEAL CELL STRUCTURE**
Credit	2
Teaching per Week	4 Hrs
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	June 2020
Purpose of Course	The main aspects of this paper are to describe the basic structure of typical prokaryotes and archaea. It focuses on important differences in structure between bacteria and archaea.
Course Objective	To understand the importance of cell morphology and cell size of microorganisms. To study the structural and functional aspects of microbial cell wall and cell membrane. To learn the surface structures and inclusion bodies. To gain knowledge of spores and its function. To enable students to understand flagellar motility and chemotaxis.
Course Outcomes	CO1: Student**s** shall understand the importance of size and morphology of microorganisms.Students shall gain knowledge of cell membrane and its function. CO2: Enable the students to understand the structural formation of peptidoglycan and LPS.Students shall learn differences of bacterial and archaeal cell wall. CO3: Acquire knowledge of cell surface structure as well as cell inclusions. CO4: Students shall gain knowledge regarding the structure and function of flagella.Students shall learn about microbial motility and chemotaxis.
Mapping between COs with PSOs	
Pre-requisite	Basic Science

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	■					
CO2	■		■			
CO3	■	■	■		■	
CO4		■	■	■		■

Course Content	**UNIT-1:CELL MORPHOLOGY & CYTOPLASMIC MEMBRANE:** 1.1 Cell Morphology 1.2 Cell Size and the significance of being Small 1.3 Membrane Structure 1.4 Membrane Function **UNIT-2:CELL WALL AND GENETIC ELEMENTS OF PROKARYOTES:** 2.1 Peptidoglycan 2.2 LPS: The Outer Membrane 2.3 Archaeal Cell Wall 2.4 Nucleoid and Ribosomes **UNIT-3:CELL SURFACE STRUCTURE AND INCLUSIONS:** 3.1 Cell Surface Structures 3.2 Cell Inclusions 3.3 Gas Vesicles 3.4 Endospore **UNIT-4:MICROBIAL LOCOMOTION:** 4.1 Flagella and Swimming Motility 4.2 Gliding Motility 4.3 Chemotaxis and Other Taxes
Reference Books	1. Medigan M., et al., (2015) Brock Biology of Microorganisms, 14th Edition, Pearson education Ltd., (ISBN: 978-1-292-01831-7) 2. Willey J.M., Sherwood L.M. and Woolverton C.J., (2017) Prescott's Microbiology, 10th Edition, McGraw - Hill Education, (ISBN: 978-981-3151-26-0) **Further Reading:** 3. Pommerville J.C. (2014) Alcamo's Fundamental of Microbiology, 10th Edition, Jones &Barlett Pvt. Ltd., (ISBN: 978-0-07-462320-6)
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

<table>
<tr><td>Course Code</td><td>MB 202</td></tr>
<tr><td>Course Title</td><td>NUTRITION AND GROWTH OF BACTERIA</td></tr>
<tr><td>Credit</td><td>2</td></tr>
<tr><td>Teaching per Week</td><td>4 Hrs</td></tr>
<tr><td>Minimum weeks per Semester</td><td>15 (Including Classwork, examination, preparation, holidays etc.)</td></tr>
<tr><td>Effective From</td><td>June 2020</td></tr>
<tr><td>Purpose of Course</td><td>The main objective of this paper is to understand diversified nutritional requirements of microorganisms and their cultivation using various different media. It also focuses on bacterial and archaeal reproduction, cell cycle, growth curve and effect of various environmental factors on growth of microorganisms.</td></tr>
<tr><td>Course Objective</td><td>To understand modes of bacterial nutrition, nutritional requirements and its uptake.
To distinguish microorganisms as per their nutritional types.
To understand bacterial cell cycle, growth curve, growth measurement.
To gain understanding of cultivation of bacteria and its enrichment.
To learn the effect of environmental factors on growth.</td></tr>
<tr><td>Course Outcomes</td><td>CO1: Students shall gain knowledge regarding the nutritional requirements of bacteria.Enable the students to classify microorganisms on their nutritional types.
CO2: Students shall learn bacterial reproduction. Students shall gain knowledge of bacterial cell cycle, growth curve and measurements of growth.
CO3: Students shall gain knowledge of cultivation of bacteria on different media.Acquire knowledge regarding pure culture, isolation and enrichment.
CO4: Gain understanding regarding the various environmental factors affecting the growth of microorganisms.</td></tr>
<tr><td>Mapping between COs with PSOs</td><td>
<table>
<tr><td></td><td>PSO1</td><td>PSO2</td><td>PSO3</td><td>PSO4</td><td>PSO5</td><td>PSO6</td></tr>
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<tr><td>Pre-requisite</td><td>Basic Science</td></tr>
<tr><td>Course Content</td><td>UNIT-1:BACTERIAL NUTRITION:
1.1Common nutritional requirements
1.2 Requirements of carbon, hydrogen, oxygen and electrons</td></tr>
</table>

	1.3 Nutritional types of microorganisms 1.4 Requirements of Nitrogen, Phosphorus, sulphur and growth factors 1.5 Uptake of nutrients **UNIT-2:BACTERIAL GROWTH:** 2.1 Bacterial and Archaeal reproduction by binary fission 2.2 Bacterial cell cycle 2.3 Bacterial Growth curve 2.4 Microbial population size measurement 2.5 Chemostat and turbidostat for Continuous culture **UNIT-3:CULTIVATION OF BACTERIA:** 3.1 Culture media 3.2 Cultivation of aerobes and anaerobes 3.3 Enrichment and isolation of pure culture 3.4 Microbial growth on solid media **UNIT-4:ENVIRONMENTAL FACTORS AND GROWTH:** 4.1 solute and water activity pH 4.2 Temperature 4.3 Oxygen concentration 4.4 Pressure 4.5 Radiation
Reference Books	1. Willey J.M., Sherwood L.M. and Woolverton C.J., (2017) Prescott's Microbiology, 10th Edition, McGraw - Hill Education, **(**ISBN: 978-981-3151-26-0) 2. Willey J.M., Sherwood L.M. and Woolverton C.J., (2008) Prescott, Harley and Klein's Microbiology, 7th Edition, McGraw - Hill Education, (ISBN: 978-007126727-4) **Further Reading:** Pelczar, Chan and Krieg, (2001), Microbiology-Concepts and Application, 5thEdition,McGrawHll, **(**ISBN: 9780074623206**)**
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

<table>
<tr><td>Course Code</td><td>Practical Core 1: MBP-203</td></tr>
<tr><td>Course Title</td><td>Microbiology practical</td></tr>
<tr><td>Credit</td><td>2</td></tr>
<tr><td>Teaching per Week</td><td>4 Hrs</td></tr>
<tr><td>Minimum weeks per Semester</td><td>15 (Including Classwork, examination, preparation, holidays etc.)</td></tr>
<tr><td>Effective From</td><td>June 2020</td></tr>
<tr><td>Purpose of Course</td><td>To provide hand’s on experience of using instruments in the laboratory for microbiology purpose.</td></tr>
<tr><td>Course Objective</td><td>Microbiology is practical based course so main objective of this course is to acquaint students about how to isolate, enrich and observe bacteria by learning basic fundamental techniques.</td></tr>
<tr><td>Course Outcomes</td><td>CO1-CO7 : To learn different staining techniques and observation of different type of cells under microscope.
CO8 : To learn how to culture bacteria.
CO9 : This group of practical’s is based on isolation of bacteria.
CO10: To learn isolation of anaerobic bacteria.
CO11-12 : To learn about preservation and the factors which influence the growth of bacteria.</td></tr>
<tr><td>Mapping between COs with PSOs</td><td>
<table>
<tr><td></td><td>PSO1</td><td>PSO2</td><td>PSO3</td><td>PSO4</td><td>PSO5</td><td>PSO6</td></tr>
<tr><td>CO1</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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<tr><td>CO11</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO12</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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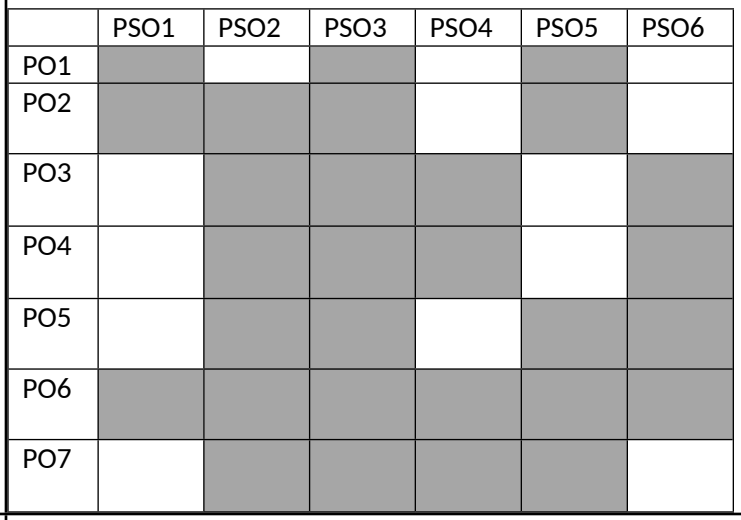
</td></tr>
<tr><td>Pre-requisite</td><td>Basic science</td></tr>
<tr><td>Course Content</td><td>1. Cell wall staining – Dyar’s method.
2. Flagella staining – Leifson’s method.
3. Cytoplasmic membrane staining by victoria blue stain.
4. Endospore staining – Snyder’s modification of Dorner’s method.
5. Nucleus staining- Feulgen’s method.</td></tr>
</table>

	6. Observation of capsule in bacteria by Maneval's method. 7. Metachromatic granules staining-Albert's method. 8. Techniques for Cultivation of bacteria: a)Broth culture b)Slant culture c)Stab culture. 9. Techniques for Isolation of bacteria: a)Streak plate method b)Pour plate method c)Spread plate method. 10. Influence of oxygen on growth of bacteria and Cultivation of Anaerobic bacteria (Thioglycollate medium). 11. Maintenance and preservation of bacteria. 12. Influence of Environmental factors on microbial growth: a)Temperature b)pH of media c)Osmotic pressure
Reference Books	1. Patel R.J. and Patel R.K. (2016) Experimental microbiology Volume I, 9th Edition.Aditya, 2. Patel R.J. and Patel R.K. (2017) Experimental microbiology Volume II, 9th Edition. Aditya, 3. Cappuccino J.G. (2016) Microbiology; A Laboratory Manual, 11th Edition Pearson Edication (Singapore) Pvt. Ltd.(ISBN: 978-9332535190) 4. Aneja K.R. (2001) Experiments in Microbiology, Plant Pathology, Tissue culture and Mushroom production technology, 3rd Edition, New Age International Publishers, (ISBN: 978-9386418302)
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

B.Sc. Microbiology III and IV

Name of Program	**B. Sc. Microbiology**
Abbreviation	**MB**
Duration	**2 Years**
Eligibility Criteria	Basic Science
Objective of Program	To convey scientific and technological knowledge and information with modern age orientation. To help young learners and realize that science and technology, both hand in hand can enrich and develop a personality, thus promising a life of success and achievement.
Program Outcome	PO1: Students shall learn various aspects of microbiology such as bacteriology, virology, algology, microbial physiology, bacterial genetics, immunology, biochemistry, rDNA technology. PO2: Students shall gain knowledge of applied microbiology such as industrial microbiology, environmental microbiology, industrial microbiology, food and dairy microbiology. PO3: Students shall learn about the presence of microorganisms in air, water, soil and its role in developing a sustainable environment. PO4: Students shall acquire the awareness regarding the importance of microorganisms in plant, animal, human health and diseases. PO5: Students shall gain knowledge of microbial technology and its applications in in the production of industrially important microbial products. PO6: Students shall become aware of the role of microbes in the development of molecular biology and the advancements in genetic modifications technologies. PO7: Generate skilled manpower ready to use by industries in various sectors.
Program Specific Outcomes	Students will be able to appear and qualify for competitive exams like NET, GSET, and GATE. They will be skilled enough to join any research institute, Biopharma industry or even start ventures of their own. PSO1: Students will develop skill to observe, isolate, identify and cultivate microorganisms. PSO2: Students will acquire and demonstrate proficiency in good laboratory practices in microbiology laboratory. PSO3: Students will develop practical skills of tools and techniques used to study microbiology. PSO4:Students will develop oral and written communication skills, effective presentation skills and interpretation skill from observed results. PSO5: Students will be graduates in microbiology who shall

	understand the societal problems and play a vital role by providing microbial solutions. PSO6: Students will be able to build their careers in public and global health, environmental organizations, food, pharmaceuticals and fermentation industries.
Mapping between POs and PSOs	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
PO1						
PO2						
PO3						
PO4						
PO5						
PO6						
PO7						

Medium of Instruction	English
Program Structure	Semester III

Course Code	Title	Teaching per week		Course Credits	University Examination		Internal Marks	Total Marks
		Theory	Practical		Duration	Marks		
	MB- 301	2	-	2	2 Hrs	50	20	70
	MB- 302	2	-	2	2 Hrs	50	20	70
	MB- 303	2	-	2	2 Hrs	50	20	70
	MB- 304	-	6	3	2+2 Hrs	60	30	90
	Total	6	6	9	10 Hrs	210	90	300

Program Structure	Semester IV

Course Code	Title	Teaching per week		Course Credits	University Examination		Internal Marks	Total Marks
		Theory	Practical		Duration	Marks		
	MB- 401	2	-	2	2 Hrs	50	20	70
	MB- 402	2	-	2	2 Hrs	50	20	70
	MB- 403	2	-	2	2 Hrs	50	20	70
	MB- 404	-	6	3	2+2 Hrs	60	30	90
	Total	6	6	9	10 Hrs	210	90	300

B.Sc. 3rd Semester

<table>
<tr><td>Course Code</td><td>MB 301</td></tr>
<tr><td>Course Title</td><td>Principle of bacterial systematic</td></tr>
<tr><td>Credit</td><td>2</td></tr>
<tr><td>Teaching per Week</td><td>2Hrs</td></tr>
<tr><td>Minimum weeks per Semester</td><td>15 (Including Classwork, examination, preparation, holidays etc.)</td></tr>
<tr><td>Effective From</td><td>June 2019</td></tr>
<tr><td>Purpose of Course</td><td>The paper explores microbial taxonomy and classification of bacteria using an evolutionary framework. Bacterial taxonomy and phylogeny gives an understanding regarding degree of prokaryotic diversity unmatched by eukaryotic unicellular and multicellular organisms.</td></tr>
<tr><td>Course Objective</td><td>• To understand taxonomic ranks and taxonomic phlogeny
• To study classical and molecular characteristics for microbial taxonomy
• To understand Bergey's manual of systematic bacteriology
• To study arachea and its classification
• To aquire knowledge of taxonomy of proteobacteria</td></tr>
<tr><td>Course Outcomes</td><td>CO 1: Students will learn evolutionary process of microorganisms. Students will able to classify microorganisms based on their cultural and molecular characteristics.
CO 2: Students will gain knowledge of the unique characteristics of archea , its adaptation and importance
CO 3: Students shall understand the major classes of proteobacteria and important phyla
CO 4: Students shall understand aerobic endospore former .</td></tr>
<tr><td>Mapping between COs with PSOs</td><td>
<table>
<tr><td></td><td>PSO1</td><td>PSO2</td><td>PSO3</td><td>PSO4</td><td>PSO5</td><td>PSO6</td></tr>
<tr><td>CO1</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO2</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO3</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO4</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>Pre-requisite</td><td>12th Science with Biology Subject</td></tr>
</table>

Course Content	

Course Content

	UNIT 1	Microbial Taxonomy and the Evolution of Diversity
		Teaching Duration: Lectures
1.1	Microbial Taxonomy	
1.2	Taxonomic Ranks	
1.3	Microbial taxonomy and phylogeny 1.3.1 Classical Characteristics 1.3.2 Molecular Characteristics: Nucleic acid hybridization, Nucleic acid base composition	
1.4	Evolutionary process and the concept of microbial species	
1.5	Bergey's Manual of systematic bacteriology	

	UNIT 2	Taxonomy of Archaea
		Teaching Duration:Lectures
2.1	Overview of Archaea	
2.2	Major groups of *Archaea*	
2.3	Phylum *Crenarchaeota*	
2.4	Phylum *Euryarchaeota* 2.4.1 Methanogens and Methanotrophs 2.4.2 Haloarchaea	

	UNIT 3	Taxonomy of Proteobacteria
		Teaching Duration:Lectures
3.1	Class *Alphaproteobacteria*: Order *Rhizobiales*	
3.2	Class *Beta Proteobacteria*: Order *Hydrogenophiales*	
3.3	Class *Gamma Proteobacteria*: Order *Enterobacteriales*	
3.4	Class Delta *Proteobacteria*: Order *Bdellovibrionales*	
3.5	Class *Epsiloneproteobacteria*	

	UNIT 4	Important groups of bacteria
		Teaching Duration:Lectures
4.1	Class *Bacilli*: Aerobic endospore forming bacteria	
4.2	Class *Mollicutes*	
4.3	Phylum *Cyanobacteria*	
4.4	Phylum *Spirochaetes*	
4.5	Phylum *Bacteroidetes*	

Reference Books	**Recommended References:** • Lory, S., Perry, J. J., Gunsalus, R. P., Staley, J. T. (2007). Microbial Life. 2nd Edition, United Kingdom: Sinauer Associates. ISBN: 9780878936854, 0878936858 • Pelczar, Chan and Krieg, (1993), *Microbiology-Concepts and Application*, International Edition, McGraw-Hill. ISBN: 9780071129145 • Sherwood, L., Willey, J. M., Woolverton, C. J. (2017). Prescott'sMicrobiology. Singapore: McGraw-Hill Education.10th Edition, 2017. ISBN: 9789813151260, 9813151269. • Tortora G.J., and Funke B.R. (2016), *Microbiology an Introduction*, 12th Ed., Pearson, ISBN: 9781292099149
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

Course Code	**MB : 302**
Course Title	Control of microorganism in the environment
Credit	2
Teaching per Week	2 Hrs
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	June 2019
Purpose of Course	The paper includes the study of the control and destruction of microorganisms. It includes the physical and chemical methods to control pathogens and prevent their transmission and to reduce or eliminate microbes responsible for the contamination of food, water and other substances.
Course Objective	• To understand the principle of controlling the presence of microorganisms. • To study the physical agents and mechanisms used for the control. • To learn the effect of various chemical agents used for the microbial control. • To understand the mechanism of control of chemical agents. • To acquire the ability to select the control agent in the environment.
Course Outcomes	CO 1: Students will gain knowledge of the role of microbial control in disease transmission. CO 2: Gain knowledge of physical and mechanical of microbial control and mode of action of each

	CO 3: Students shall understand the major chemical agents and its microbicidal effect. CO 4: Shall enable the students to understand the machanisms of chemical control.
Mapping between COs with PSOs	
Pre-requisite	Basic science

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1						
CO2						
CO3						
CO4						

Course Content

Course Content

	UNIT 1	Basic Principles of Microbial Control
		Teaching Duration: Lectures 07
1.1	Terminology of Microbial Control	
1.2	Microbial Death Rates	
1.3	Action of Antimicrobial Agents	
1.4	The Selection of Microbial Control Methods	
1.5	Situational Considerations	

	UNIT 2	Mechanical and Physical Methods for Microbial Control
		Teaching Duration: Lectures 08
2.1	Filtration	
2.2	Heat Related Methods	
2.3	Refrigeration and Freezing	
2.4	Desiccation and Lyophilization	
2.5	Osmotic Pressure	
2.6	Radiation	

	UNIT 3	Chemical Methods for Microbial Control – I
		Teaching Duration: Lectures 07
3.1	Choosing a Microbicidal Chemical	
3.2	Factors Affecting Germicidal Activity of Chemicals	
3.3	The Halogens Antimicrobial Chemical	
3.4	Phenols: Its derivatives and Applications	
3.5	Alcohols	

	UNIT 4	Chemical Methods for Microbial Control - II
		Teaching Duration: Lectures 08
4.1	Hydrogen Peroxide and related Germicides	
4.2	Chemicals with Surface Action: Detergents	
4.3	Heavy Metals	
4.4	Aldehydes	
4.5	Gaseous Sterilants and Disinfectants	
4.6	Dyes	
4.7	Acid and Alkalies	

Reference Books	**Recommended References:** • Bauman R. W., (2003), *Microbiology, Pearson/Benjamin-Cummings*, (ISBN: 0-8-53-7590-2) • Cowan M. K. and Talaro K. P., (2006), *Microbiology: A Systems Approach*, Mc-Graw Hill Higher Education, (ISBN: 0-07-291804-7) • Nester E. W., Anderson D. G., Roberts Jr. C. E., Pearsall N. N. and Nester T. M., *Microbiology*, International Edition, Mc-Graw Hill Higher Education, (ISBN: 0-07-121493-3) **Further Reading:** • Pommerville J. C., (2014), *Alcamo's Fundamentals of Microbiology*, 10th edition, Jones and Bartlett Learning, (ISBN: 978-93-80853-5374-1) • Willey J. M., Sherwood L. M. and Woolverton C. J., (2017), *Prescott's Microbiology*, 10th edition, Mc-Graw Hill Education, (ISBN: 978-981-3151-26-0)
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

Course Code	MB 303
Course Title	Virology
Credit	2
Teaching per Week	2 Hrs
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	June 2019
Purpose of Course	The aim of the paper is to realize the increasing importance of virology. Students shall learn the origin, basic structure of virus and its classification. It teaches the cultivation and reproduction of virus. The paper also includes the role of virus in disease as well as cancer but also a study on viruses associated with plant, animal, insects and archaeal viruses.
Course Objective	• To give an overview of medically important virus families. • To describe the structure, classification and cultivation of viruses. • To understand the replication strategies of viruses. • To study virus like infectious particles • To study the role of virus and virus host.

<table>
<tr><td>Course Outcomes</td><td>CO 1: Students will gain knowledge of the structure of viruses and its origin
CO 2: Students shall learn about classification of viruses and knowledge of emerging viruses threatening the world
CO 3: Enable students to understand virus replication.
CO 4: Students shall understand the role of viruses in cancer.</td></tr>
<tr><td>Mapping between COs with PSOs</td><td>
<table>
<tr><td></td><td>PSO1</td><td>PSO2</td><td>PSO3</td><td>PSO4</td><td>PSO5</td><td>PSO6</td></tr>
<tr><td>CO1</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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<tr><td>CO3</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO4</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>Pre-requisite</td><td>Basic science</td></tr>
</table>

Course Content	**Course Content** **UNIT 1 — Microbial Taxonomy and the Evolution of Diversity** — Teaching Duration: Lectures 07 1.1 Microbial Taxonomy 1.2 Taxonomic Ranks 1.3 Microbial taxonomy and phylogeny 1.3.1 Classical Characteristics 1.3.2 Molecular Characteristics: Nucleic acid hybridization, Nucleic acid base composition 1.4 Evolutionary process and the concept of microbial species 1.5 Bergey's Manual of systematic bacteriology **UNIT 2 — Taxonomy of Archaea** — Teaching Duration: Lectures 07 2.1 Overview of Archaea 2.2 Major groups of *Archaea* 2.3 Phylum *Crenarchaeota* 2.4 Phylum *Euryarchaeota* 2.4.1 Methanogens and Methanotrophs 2.4.2 Haloarchaea **UNIT 3 — Taxonomy of Proteobacteria** — Teaching Duration: Lectures 08 3.1 Class *Alphaproteobacteria*: Order *Rhizobiales* 3.2 Class *Beta Proteobacteria*: Order *Hydrogenophiales* 3.3 Class *Gamma Proteobacteria*: Order *Enterobacteriales* 3.4 Class Delta *Proteobacteria*: Order *Bdellovibrionales* 3.5 Class *Epsiloneproteobacteria* **UNIT 4 — Important groups of bacteria** — Teaching Duration: Lectures 08 4.1 Class *Bacilli*: Aerobic endospore forming bacteria 4.2 Class *Mollicutes* 4.3 Phylum *Cyanobacteria* 4.4 Phylum *Spirochaetes* 4.5 Phylum *Bacteroidetes*
Reference Books	**Recommended References:** • Black, J. G. (2012). Microbiology: Principles and explorations. Hoboken, NJ: Wiley. ISBN: 9780470541098, 0470541091. • Sherwood, L., Willey, J. M., Woolverton, C. J. (2008). Prescott's Microbiology. Singapore: McGraw-Hill Education.7th Edition and 10th edition. 2017. ISBN: 0073302082, 9780073302089 and ISBN: 9789813151260, 9813151269.
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc.

	70% External based on semester end University examination

Course Code	**MBP: 304**
Course Title	**Semester III Practical**
Credit	3
Teaching per Week	6 Hrs
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	June 2019
Purpose of Course	Purpose of this course is to understand the purity of culture and effect of different parameters on growth of microorganisms
Course Objective	• To understand the purity of culture • To study different parameters that effect on growth of the bacteria • To understand the germicidal effect of disinfectant on growth of microorganisms
Course Outcomes	CO 1: students will understand the characteristics of different microorganisms CO 2: CO 3: To understand the germicidal effect on batreia CO 4: CO 5: To understand antimicrobial effect on microorganisms. CO 6: CO 7: To gain knowledge about temperature and time exposure on growth of bacteria. CO 8 - CO12: To learn about various pure culture of microorganisms.
Mapping between COs with PSOs	
Pre-requisite	Basic science

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	■					
CO2	■		■			
CO3	■	■	■		■	
CO4		■	■	■		■
CO5	■		■		■	■
CO6	■	■		■		■
CO 7	■	■		■		■
CO 8	■	■		■		■
CO 9	■	■		■		■
CO 10	■	■		■		■
CO 11	■	■		■		■
CO 12	■	■		■		■

Course Content	**S.Y.B.Sc. Microbiology** **Semester – III Practicals** **(Time Duration: 06 Hours/week)** **MBP 304: Practicals** 1. Enumeration of bacteria by Heterotrophic plate count method (HPC) 2. Action of antiseptics and disinfectants on bacteria. 3. Effect of hand sanitizer on skin flora. 4. Lethal action of U.V. rays on bacteria 5. Lethal action of heavy metals on bacteria 6. Demonstration of lysis of bacteria by bacteriophage. 7. Determination of TDP & TDT. 8. Study of biochemical reactions. 9. Pure culture study of *Escherichia coli* and *Klebseilla mobillis* (formerly *Enterobacter aerogenes)* 10. Pure culture study of *Proteus vulgaris, Serratia marcescens* and *Pseudomonas aeruginosa.* 11. Pure culture study of *Bacillus megaterium, Bacillus subtilis, Bacillus cereus.* 12. Pure culture study of *Staphylococcus aureus, Staphylococcus epidermidis.*
Reference Books	**References:** • Aneja, K.R., (2003). *Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Production Technology,* 4th edition., New Age International Publishers. • Cappuccino, J.G., (2016). *Microbiology: A Laboratory Manual,* 11th ed., Pearson Education (Singapore) Pvt. Ltd. • Patel, R. J., & Patel, K. R., (2011). Experimental Microbiology, Vol. 2, 8th ed., Aditya. • Patel, R. J., & Patel, K. R., (2015). Experimental Microbiology, Vol. 1, 9th ed., Aditya.
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

B.Sc. 4rd Semester

<table>
<tr><td>Course Code</td><td>MB 401</td></tr>
<tr><td>Course Title</td><td>Biological moleculs</td></tr>
<tr><td>Credit</td><td>2</td></tr>
<tr><td>Teaching per Week</td><td>2 Hrs</td></tr>
<tr><td>Minimum weeks per Semester</td><td>15 (Including Classwork, examination, preparation, holidays etc.)</td></tr>
<tr><td>Effective From</td><td>June 2019</td></tr>
<tr><td>Purpose of Course</td><td>Course overview:
The paper gives an understanding of biomolecules found in all living organisms including microbes. Students shall learn important biomolecules such as proteins, enzymes, carbohydrates, lipids and nucleic acids. They shall become aware of the structure, types and the important functions of biomolecules.</td></tr>
<tr><td>Course Objective</td><td>• To study the structure and properties of amino acids and proteins.
• To understand classification of enzymes and enzyme activity.
• To understand types of carbohydrates and its importance.
• To gain knowledge of lipids, its structure and functions.
• To enable students to understand DNA and RNA.</td></tr>
<tr><td>Course Outcomes</td><td>CO 1: Students shall understand the structure of Amino acid and its role in peptide bond formation also gain knowledge about structure and function of protein and enzymes.
CO 2: Students will understand the stereochemistry of carbohydrates and its functions.
CO 3: Students shall acquire knowledge about lipids , their classification and importance
CO 4: acquire knowledge about structure and denaturation of nucleic acids.</td></tr>
<tr><td>Mapping between COs with PSOs</td><td>
<table>
<tr><td></td><td>PSO1</td><td>PSO2</td><td>PSO3</td><td>PSO4</td><td>PSO5</td><td>PSO6</td></tr>
<tr><td>CO1</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO2</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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	CO3 CO4
Pre-requisite	Basic science

Course Content	

	UNIT 1	Amino Acids, Proteins and enzymes
		Teaching Duration:Lectures 08
1.1	Amino Acids Exist in a Three-Dimensional world	
1.2	Individual Amino Acids: Their Structures and Properties	
1.3	The Peptide Bond	
1.4	Protein Structure and Function	
1.5	Chemical nature of enzymes	
1.6	Nomenclature and classification of enzymes	
1.7	Factor affecting enzyme activity	
1.8	Isoenzymes	

	UNIT 2	Carbohydrates
		Teaching Duration: Lectures 07
2.1	Sugars: Their structures and stereochemistry	
2.2	Reactions of monosaccharides	
2.3	Some Important oligosaccharides	
2.4	Structures and functions of polysaccharides	

	UNIT 3	Lipids
		Teaching Duration: Lectures 08
3.1	Classification lipids	
3.2	Fatty acids	
3.3	Glycerol lipid	
3.4	Lipid devoid of glycerol	
3.5	Complex lipids	
3.6	Lipids and biological membranes	

	UNIT 4	Nucleic Acid
		Teaching Duration:Lectures 07
4.1	Levels of Structure in Nucleic Acids	
4.2	The Covalent Structure of Polynucleotides	
4.3	The Structure of DNA	
4.4	Denaturation of DNA	
4.5	Types of RNA and their Structures	

Reference Books	**Recommended References:** • Campbell, M. K., & Farrell, S. O. (2012). *Biochemistry*. Belmont, CA: Brooks/Cole, Cengage Learning. ISBN: 9780840068583 0840068581. • Rastogi, S. C., *Biochemistry* (2015), 2nd Edi. ISBN:9788171339389. **Further reading:** • Berg and Stryer, (2007) *Biochemistry*, 6th Ed. W H Freeman pub., ISBN: 9780716746843 • Murray, R. K., Granner, D. K., Mayes, P. A., & Rodwell, V. W. (2015). *Harper Biochemistry*, 30th Edi. Appleton and Lange. • Voet and Voet, (2008) *Fundamentals of biochemistry*, 3rd Ed, Johns Wiley & Sons, Asia ISBN: 978-0470129302
Teaching Methodology	Class work, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

Course Code	MB : 402
Course Title	Mycology, Phycology and Protozoology
Credit	2
Teaching per Week	2Hrs
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	June 2019
Purpose of Course	• To understand eukaryotic microorganisms and its importance. • To study distinguishing characteristics, reproduction and cultivation of fungi. • To understand major classes of fungi. • To give understanding of characteristics of algae and its economic importance. • To gain knowledge of occurrence, importance and reproduction of protozoa

<table>
<tr><td>Course Objective</td><td>

To understand eukaryotic microorganisms and its importance.
To study distinguishing characteristics, reproduction and cultivation of fungi.
To understand major classes of fungi.
To give understanding of characteristics of algae and its economic importance.
To gain knowledge of occurrence, importance and reproduction of protozoa

</td></tr>
<tr><td>Course Outcomes</td><td>CO 1: Enable students to understand the structural differences of prokaryotic and eukaryotic microorganisms
CO 2: Give an insight of different fungal groups and its importance.
CO 3: Students shall learn algal ecology , its characteristic and its importance.
CO 4: Gain knowledge of occurrence, importance and reproduction of protozoa.</td></tr>
<tr><td>Mapping between COs with PSOs</td><td>
<table>
<tr><td></td><td>PSO1</td><td>PSO2</td><td>PSO3</td><td>PSO4</td><td>PSO5</td><td>PSO6</td></tr>
<tr><td>CO1</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO2</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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<tr><td>CO4</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>Pre-requisite</td><td>Basic science</td></tr>
</table>

Course Content	Course Content

	UNIT 1	Mycology
		Teaching Duration: Lectures 07
1.1	Importance of fungi	
1.2	Distinguishing characteristics of fungi	
1.3	Morphology of fungi	
1.4	Reproduction of fungi	
1.5	Cultivation of fungi	

	UNIT 2	Classification of fungi
		Teaching Duration: Lectures 08
2.1	The Chytridiomycota	
2.2	The Zygomycota	
2.3	The Ascomycota	
2.4	The Basidiomycota	
2.5	The Microsporidia	
2.6	The Glomeromycota	

	UNIT 3	Phycology
		Teaching Duration: Lectures 08
3.1	Occurrence of algae	
3.2	Characteristics of algae	
3.3	Algae and diseases	
3.4	Biological and economic importance of algae	
3.5	Lichen	

	UNIT 4	Protozoology
		Teaching Duration: Lectures 07
4.1	Occurrence of protozoa	
4.2	Ecology of protozoa	
4.3	The importance of protozoa	
4.4	Morphology of protozoa	
4.5	Reproduction of protozoa	

Reference Books	**Recommended References:** • Pelczar M. J. and Chan E. C. S., (1998), *Microbiology*, 5th Ed., Tata-Mc Graw Hill. • Sherwood, L., Willey, J. M., Woolverton, C. J. (2017). *Prescott Microbiology*. Singapore: McGraw-Hill Education.10th Edition, 2017. ISBN: 9789813151260, 9813151269. **Further reading:** • Tortora G.J., and Funke B.R. (2016), *Microbiology: an Introduction*, 12 Ed., Benjamin Cummings.
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

<table>
<tr><td>Course Code</td><td>MB 403</td></tr>
<tr><td>Course Title</td><td>Microbial ecosystem</td></tr>
<tr><td>Credit</td><td>2</td></tr>
<tr><td>Teaching per Week</td><td>2Hrs</td></tr>
<tr><td>Minimum weeks per Semester</td><td>15 (Including Classwork, examination, preparation, holidays etc.)</td></tr>
<tr><td>Effective From</td><td>June 2019</td></tr>
<tr><td>Purpose of Course</td><td>Microbial ecology is concerned with microbial processes that occur in ecosystem. It explains how nutrient availability and environmental factors influence microbial growth in various ecosystems. Student shall understand the role of microorganisms in evolution of life and balance of ecosystem. The objective of the paper is to give an understanding of the varied microbial interactions and its impact in sustenance of ecosystem.</td></tr>
<tr><td>Course Objective</td><td>• To understand the role of microbial evolution in ecological development.
• To learn the methods to study microbial ecology.
• To gain an understanding of biogeochemical cycling and effect of global climate change.
• To develop insight about microbial interactions.
• To understand the role of microorganisms in ecosystem.</td></tr>
<tr><td>Course Outcomes</td><td>CO 1: Shall give an insight of microbial rolein evolution of life.
CO 2: Give an understanding of biogeochemical cycling.
CO 3: Students shall gain knowledge of microbial interactions and its significance.
CO 4: Gain knowledge of distribution and role of microorganisms in different habits and ecosystems.</td></tr>
<tr><td>Mapping between COs with PSOs</td><td>
<table>
<tr><td></td><td>PSO1</td><td>PSO2</td><td>PSO3</td><td>PSO4</td><td>PSO5</td><td>PSO6</td><td>PSO7</td><td>PSO8</td></tr>
<tr><td>CO1</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO2</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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</table>
</td></tr>
<tr><td>Pre-requisite</td><td>Basic Science</td></tr>
</table>

Course Content	Course Content UNIT 1 — MICROBIAL EVOLUTION AND ECOLOGY — Teaching Duration: Lectures 08 1.1 The origin of life 1.2 Chemical evolution 1.3 Cellular Evolution 1.4 Ribosomal RNA analysis for tracing microbial evolution 1.5 Genetic basis of evolution

1.6	Methods in microbial ecology

	UNIT 2	BIOGEOCHEMICAL CYCLING AND GLOBAL CLIMATE CHANGE
		Teaching Duration: Lectures 08
2.1	Global Climate Change; Global Infectious Disease Change	
2.2	Biogeochemical Cycling 2.2.1 Carbon cycle 2.2.2 Nitrogen Cycle 2.2.3 Phosphorus Cycle 2.2.4 Sulfur Cycle	
2.3	Interaction between Elemental Cycles	
2.4	Global Climate Change: Biogeochemical cycling out of balance	

	UNIT 3	MICROBIAL INTERACTIONS
		Teaching Duration: Lectures 07
3.1	Mutualism	
3.2	Cooperation	
3.3	Commensalism	
3.4	Predation	
3.5	Parasitism	
3.6	Amensalism	
3.7	Competition	

	UNIT 4	MICROORGANISMS AND ECOSYSTEMS
		Teaching Duration: Lectures 07
4.1	Microorganisms in terrestrial environments 4.1.1 Soils as an important microbial habitat 4.1.2 Microbe-plant interactions	
4.2	Microorganisms in marine and freshwater ecosystems 4.2.1 Water as a microbial habitat 4.2.2 Microorganisms in marine ecosystems 4.2.3 Microorganisms in freshwater ecosystems	

Reference Books	**Recommended References:** • Ronald M. Atlas & Richard Bartha (2005) *Microbial Ecology: Fundamentals and Applications*, 4th Ed., Pearson Education. ISBN: 81-297-0771-3. • Wiley, J., & Sherwood, L. (2013). *Prescott, Harley, and Klein's Microbiology*, 10th Ed., McGraw-Hill Science/Engineering/Math, ISBN: 9780073402406. **Further reading:** • McArthur, J. Vaun (2006). *Microbial Ecology: An Evolutionary Approach*, Academic Press. 416 pp. ISBN 0123694914. • Mitchell R., Gu Pelczar Ji Dang, Chan and Krieg, (1993), *Microbiology-Concepts and Application*, International Edition, McGraw-Hill. • Tortora G.J., and Funke B.R. (2016), *Microbiology an Introduction*, 12 Ed., Benjamin Cummings.
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

Course Code	**MBP : 404**
Course Title	**Semester IV Microbiology Practical**
Credit	3
Teaching per Week	6 Hrs
Minimum weeks per Semester	15 (Including Class work, examination, preparation, holidays etc.)
Effective From	June 2019
Purpose of Course	Purpose of the course is to understand the intracellular and extracellular enzyme activity and structure of fungi, algae and protozoa
Course Objective	• To study the qualitative analysis of protein and carbohydrates • To understand the intracellular and extracellular enzyme activity. • To study the structure and function of important fungi
Course Outcomes	CO 1- CO 2: To understand the presence of biomolecules such as protein and carbohydrates CO 3 -CO 4: To know the activity 0f intracellular and extracellular enzymes.

<table>
<tr><td></td><td>CO 5- CO 8: To understand the structure of fungi , algae and protozoa.
CO 9 –CO 12 TO learn the isolation of different organisms from natural samples.</td></tr>
<tr><td>Mapping between COs with PSOs</td><td>
<table>
<tr><td></td><td>PSO1</td><td>PSO2</td><td>PSO3</td><td>PSO4</td><td>PSO5</td><td>PSO6</td></tr>
<tr><td>CO1</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO2</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO3</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO4</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO5</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO6</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO 7</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO 8</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO 9</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO 10</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO 11</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO 12</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>Pre-requisite</td><td>Basic Science</td></tr>
</table>

Course Content	**S.Y.B.Sc. Microbiology** **Semester – IV Practicals** **(Time Duration: 06 Hours/week)** **MBP 404: Practicals** 1. Qualitative analysis of carbohydrate (Any four sugar) 2. Qualitative analysis of proteins (Any three protein) 3. Study of extracellular enzymatic activity: Amylase, Caseinase, Gelatinase, Lipase 4. Study of intracellular enzymatic activity: Deaminase, Decarboxylase, Catalase, Dehydrogenase, Oxidase. 5. Cultivation and identification of economical important fungi. (9 genera) (*Aspergillus, Penicillium, Mucor, Rhizopus, Curvularia, Helminthosporium, Cunninghamella, Fusarium, Alternaria*) 6. Study of permanent slides of algae (*Volvox, Spirogyra*, Diatoms) 7. Study of permanent slides of algae Cyanobacteria (*Nostoc, Anabena*) 8. Study of permanent slides of Protozoa (*Amoeba, Paramoecium, Euglena*). 9. Isolation of nonsymbiotic nitrogen fixing aerobic bacteria- *Azotobacter* spp. 10. Isolation of *Rhizobium* spp. from root nodules of legume plants. 11. Isolation and identification of Actinomycetes from soil. 12. Isolation of protozoa from soil
Reference Books	**References:** • Aneja, K.R., (2003). *Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Production Technology,* 4th edition., New Age International Publishers. • Cappuccino, J.G., (2016). *Microbiology: A Laboratory Manual,* 11th ed., Pearson Education (Singapore) Pvt. Ltd. • Patel, R. J., & Patel, K. R., (2011). *Experimental Microbiology,* Vol. 2, 8th ed., Aditya. • Patel, R. J., & Patel, K. R., (2015). *Experimental Microbiology*, Vol. 1, 9th ed., Aditya.
Teaching Methodology	Class work, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

B.Sc. Microbiology V to VI

Name of Program	**B.Sc Microbiology**
Abbreviation	**MB**
Duration	**2 Years**
Eligibility Criteria	Basic Science
Objective of Program	To convey scientific and technological knowledge and information with modern age orientation. To help young learners and realize that science and technology, both hand in hand can enrich and develop a personality, thus promising a life of success and achievement.
Program Outcome	PO1: Students shall learn various aspects of microbiology such as bacteriology, virology, algology, microbial physiology, bacterial genetics, immunology, biochemistry, rDNA technology. PO2: Students shall gain knowledge of applied microbiology such as industrial microbiology, environmental microbiology, industrial microbiology, food and dairy microbiology. PO3: Students shall learn about the presence of microorganisms in air, water, soil and its role in developing a sustainable environment. PO4: Students shall acquire the awareness regarding the importance of microorganisms in plant, animal, human health and diseases. PO5: Students shall gain knowledge of microbial technology and its applications in in the production of industrially important microbial products. PO6: Students shall become aware of the role of microbes in the development of molecular biology and the advancements in genetic modifications technologies. PO7: Generate skilled manpower ready to use by industries in various sectors.
Program Specific Outcomes	Students will be able to appear and qualify for competitive exams like NET, GSET, and GATE. They will be skilled enough to join any research institute, Biopharma industry or even start ventures of their own. PSO1: Students will develop skill to observe, isolate, identify and cultivate microorganisms. PSO2: Students will acquire and demonstrate proficiency in good laboratory practices in microbiology laboratory. PSO3: Students will develop practical skills of tools and techniques used to study microbiology. PSO4:Students will develop oral and written communication skills, effective presentation skills and interpretation skill from observed results. PSO5: Students will be graduates in microbiology who shall

	understand the societal problems and play a vital role by providing microbial solutions. PSO6: Students will be able to build their careers in public and global health, environmental organizations, food, pharmaceuticals and fermentation industries.
Mapping between POs and PSOs	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
PO1						
PO2						
PO3						
PO4						
PO5						
PO6						
PO7						

Medium of Instruction		English						
Program Structure		Semester V						
Course Code	**Title**	**Teaching per week**		**Course Credits**	**University Examination**		**Internal Marks**	**Total Marks**
		Theory	**Practical**		**Duration**	**Marks**		
	Foundation Compulsory	2	0	2	2 Hrs	50	20	70
	Generic Elective	2	0	2	2 Hrs	50	20	70
	Core 1	12	-	12	2x6 Hrs	300	120	420
	Practical core 1	-	12	6	2hrs	120	60	180
	Foundation Elective	2	0	2	2 Hrs	50	20	70
	Total	18	12	24	18 Hrs	570	340	810
Program Structure		Semester VI						
Course Code	**Title**	**Teaching per week**		**Course Credits**	**University Examination**		**Internal**	**Total Marks**

		Theory	Practical		Duration	Marks	Marks	
	Foundation Compulsory	2	0	2	2 Hrs	50	20	70
	Generic Elective	2	0	2	2 Hrs	50	20	70
	Core 1	12	-	12	2x6 Hrs	300	120	420
	Practical core 1	-	12	6	2hrs	120	60	180
	Foundation Elective	2	0	2	2 Hrs	50	20	70
	Total	18	12	24	18 Hrs	570	340	810

Course Code	**MB11:**
Course Title	BACTERIALGENETICS
Credit	2
Teaching per Week	2
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	June 2020
Purpose of Course	Students learn about basic molecular biology concepts of replication, transcription, translation, mutation and genetic recombination.
Course Objective	• Students develope the knowledge of basic molecular biology. • Students also learn about genetic recombination and repair mechanism.
Course Outcomes	CO1:Students will learn about clear idea of basic molecular process. CO2:Students also acquire knowledge of gene regulation, genetic recombination. CO3: Students will learn about different types of mutation.
Mapping between COs with PSOs	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1						

	CO2						
	CO3						
Pre-requisite	Basic Science						

Course Content

	UNIT1	GENOME:STRUCTUREANDREPLICATION	
	Reference: 9thPrescott	**TeachingDuration**	**10Lectures**
1.1	DNAasgeneticmaterial		
1.2	DNAStructure		
1.3	TheorganizationofDNA incells		
1.4	ReplicationofDNA		
	1.4.1 Semi-conservativeDNAreplication		**Ref:Russell**
	1.4.2 PatternsofDNAsynthesis		
	1.4.3 Thereplicationmachinery		
	1.4.4 Eventsatthereplicationfork		
	1.4.5 Terminationofreplication		

	UNIT2	GENEEXPRESSIONANDREGULATION	
	Reference: 9thPrescott	**TeachingDuration**	10**Lectures**
2.1	Theflowofgeneticinformation		
2.2	Genestructure		
2.3	Transcription		
	2.3.1 Transcriptionin*Bacteria*		
2.4	TheGenetic code		
2.5	Translation		
2.6	TheLactoseoperon: Negativecontrolofinduciblegenes		

	UNIT3	GENETICRECOMBINATIONANDEXTRACHROMOSOMAL INHERITANCE	
	Reference:9thPrescott	**TeachingDuration**	10**Lectures**
3.1	Horizontalgene transferinProkaryotes		
3.2	Recombinationatthemolecularlevel		
3.3	Transposableelements		
3.4	Bacterialplasmids		
3.5	BacterialConjugation		
3.6	DNATransformation		
3.7	Transduction		

	<table><tr><td></td><td colspan="2">**UNIT 4** **MUTATIONS AND THEIR REPAIR**</td></tr><tr><td></td><td>**Reference: Russell**</td><td>**Teaching Duration** **10 Lectures**</td></tr><tr><td>4.1 4.2 4.3 4.4 4.5</td><td colspan="2">Mutations definition Types of point mutation Spontaneous and induced mutations Reverse mutations and suppressor mutations Repair of damaged DNA</td></tr></table>
Reference Books	**REFERENCES:** Wiley,J.,andSherwood,L.(2014).Prescott, HarleyandKlein'sMicrobiology,9Ed.,McGraw-HillScience/Engineering/M Nester E.W.,AndersonD. J.,RobertsC.E.,PiveearsallN.N. andNester M.T.,(2004),Microbiology:Ahumanperspective,McGraw-Hill **FurtherReading:** Pelczar M. J. and Chan E. C. S., (1998), Microbiology, 5th ed., Tata-Mc GrawHill CowanM.K. andTalaroK.P.,(2006),Microbiology-AsystemsApproach,Mc GrawHillHigherEducation.
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

Course Code	**MB12**
Course Title	**EUCARYOTICTAXONOMY**
Credit	2
Teaching per Week	2
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	June 2020
Purpose of Course	Students will learn about differences in prokaryotic and eukaryotic structures. They also learn to differentiate differentiate single cell and multicellular organisms on the basis of taxonomy.

<table>
<tr><td></td><td></td></tr>
<tr><td>Course Objective</td><td>• Student will learn about basic cell structure.
• Stuents will know about funus,protist and muticellular parasites.</td></tr>
<tr><td>Course Outcomes</td><td>CO1: Students will acquire the basic knowledge of differences in prokaryotic and eukaryotic organisms on the basis of their structure.
CO2: Students will learn about basic parasites and arthropod vectors.</td></tr>
<tr><td>Mapping between COs with PSOs</td><td>
<table>
<tr><td></td><td>PSO1</td><td>PSO2</td><td>PSO3</td><td>PSO4</td><td>PSO5</td><td>PSO6</td></tr>
<tr><td>CO1</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO2</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>Pre-requisite</td><td>Basic Science</td></tr>
<tr><td>Course Content</td><td>
MB 12: EUCARYOTIC TAXONOMY
<table>
<tr><td></td><td>UNIT 1</td><td colspan="2">EUCARYOTIC CELL STRUCTURE</td></tr>
<tr><td></td><td>Reference: 9th Prescott</td><td>Teaching Duration</td><td>10 Lectures</td></tr>
<tr><td>1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9
1.10
1.11
1.12</td><td colspan="3">Typical eukaryotic cells
Eukaryotic cell envelopes
Cytoplasm of Eucaryotes
Endoplasmic reticulum
Golgi apparatus
Lysosomes
Nucleus
Ribosomes
Mitochondria
Hydrogenosomes
Chloroplasts
External cell structures</td></tr>
</table>
<table>
<tr><td></td><td>UNIT 2</td><td colspan="2">THE FUNGI (EUMYCOTA)</td></tr>
<tr><td></td><td>Reference: 9th Prescott</td><td>Teaching Duration</td><td>10 Lectures</td></tr>
<tr><td>2.1
2.2
2.3
2.4
2.5</td><td colspan="3">Fungal Distribution & Importance
Fungal Structure
Fungal Reproduction
Zygomycota-Rhizopus
Ascomycota-Saccharomyces</td></tr>
</table>
<table>
<tr><td></td><td>UNIT 3</td><td colspan="2">THE PROTISTS</td></tr>
<tr><td></td><td>Reference: 9th Prescott</td><td>Teaching Duration</td><td>10 Lectures</td></tr>
<tr><td>3.1
3.2
3.3
3.4</td><td colspan="3">Overview of protestProtist
Morphology
Encystment and excystment
Reproductive cells and structure</td></tr>
</table>
</td></tr>
</table>

	3.5 Supergroup- Amoebozoa 3.6 Supergroup- Archaeplastida **UNIT 4 MULTICELLULAR PARASITES AND ARTHROPOD VECTORS** **Reference: Nester** **Teaching Duration** **10 Lectures** 4.1 Introduction 4.2 Arthropods Mosquitoes Fleas Lice Tick Mites 4.3 Helminths Nematodes (Roundworms) Cestodes (Tapeworms) Trematodes (Flukes)
Reference Books	**REFERENCES:** Wiley,J.,andSherwood,L.(2014).Prescott, HarleyandKlein'sMicrobiology,9Ed.,McGraw-HillScience/Engineering/M Nester E.W.,AndersonD. J.,RobertsC.E.,PiveearsallN.N. andNester M.T.,(2004),Microbiology:Ahumanperspective,McGraw-Hill **FurtherReading:** Pelczar M. J. and Chan E. C. S., (1998), Microbiology, 5th ed., Tata-Mc GrawHill CowanM.K. andTalaroK.P.,(2006),Microbiology-AsystemsApproach,Mc GrawHillHigherEducation.
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

Course Code	**MB13**
Course Title	**RECOMBINANTDNATECHNOLOGY**
Credit	2
Teaching per Week	2
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)

<table>
<tr><td>Effective From</td><td>June 2020</td></tr>
<tr><td>Purpose of Course</td><td>To aware the students with advanced techniques of genetic engineering and its tools. To make them able to apply these techniques in the field of medicine, recombinant protein production and in agriculture.</td></tr>
<tr><td>Course Objective</td><td>To make students learn about genetic engineering and its tools.</td></tr>
<tr><td>Course Outcomes</td><td>CO1: Student become aware of all these technology and able to utilize it in field of agriculture, Medicine and Pharmacy Industry.
CO2: Students will able to learn about application skills related to genetic engineering.</td></tr>
<tr><td>Mapping between COs with PSOs</td><td>
<table>
<tr><td></td><td>PSO1</td><td>PSO2</td><td>PSO3</td><td>PSO4</td><td>PSO5</td><td>PSO6</td></tr>
<tr><td>CO1</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO2</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>Pre-requisite</td><td>Basic Science</td></tr>
<tr><td>Course Content</td><td>
<table>
<tr><td></td><td>UNIT1</td><td colspan="2">AIMSOFGENETICENGINEERING</td></tr>
<tr><td></td><td>Reference:Trevan</td><td>TeachingDuration</td><td>10Lectures</td></tr>
<tr><td>1.1

1.2</td><td colspan="3">Techniquesforgenemanipulation
ConventionalBreeding
Protoplast andcellcloning
Potentialproducts ofgeneticEngineering Outline ofgenecloning</td></tr>
</table>
</td></tr>
</table>

	UNIT 2	TOOLS AND TECHNIQUES OF GENETIC ENGINEERING-I	
	Reference: Singh	**Teaching Duration**	**10 Lectures**
2.1	Restriction endonucleases		
2.2	Modification of cut ends		
2.3	Generation of DNA fragments for cloning		
2.4	Construction of c-DNA library		
2.5	Genomic library		
2.6	Comparison between c-DNA and genomic library		
2.7	Gel electrophoresis: Separation of DNA Molecules		**(Madigan)**
2.8	Nucleic acid hybridization and southern blot		**(Madigan)**

	UNIT 3	TOOLS AND TECHNIQUES OF GENETIC ENGINEERING-II	
	Reference: Singh	**Teaching Duration**	**10 Lectures**
3.1	Vector		
	3.1.1 Properties of good vector		
	3.1.2 Cloning and Expression vectors		
	3.1.3 Plasmid vectors-pBR322		
	3.1.4 Bacteriophage vectors-λ phage.		
	3.1.5 Cosmid vectors		
	3.1.6 Phagemid vectors and Phasmid vectors		
	3.1.7 Artificial chromosome vectors:BAC		
	3.1.8 Shuttle Vectors		
3.2	Gene fusion and reporter gene		**(Madigan)**
3.3	Hosts for cloning vectors		**(Madigan)**
3.4	Finding the right clone		**(Madigan)**

	UNIT 4	APPLICATIONS OF rDNA TECHNOLOGY	
	Reference: Rastogi	**Teaching Duration**	**10 Lectures**
4.1	Production of recombinant therapeutic proteins		
4.2	Production of recombinant vaccines		
4.3	Bacillus thuringiensis based biopesticides		
4.4	Development of Fungal, Bacterial and viral disease resistant plant.		

Reference Books	**REFERENCES:** Rastogi,S.,&Pathak,N.(2009).GeneticEngineering, OxfordUniversityPress.(ISBN:978-0-19-569657-8) Trevan, M.D. (1987). Biotechnology: The Biological Principles, Tata-McGraw-Hill.(ISBN:0-07-099391-2) Madigan, T.M. andMartinko, J.M.(2008).BrockBiologyofMicroorganisms,12TH Ed.,BenjaminCummings. Singh,B.D.,(2011).Biotechnology:ExpandingHorizons, KalyaniPublishers.
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

<table>
<tr><td>Course Code</td><td>MB14</td></tr>
<tr><td>Course Title</td><td>FUNDAMENTALS OFIMMUNOLOGY</td></tr>
<tr><td>Credit</td><td>2</td></tr>
<tr><td>Teaching per Week</td><td>2</td></tr>
<tr><td>Minimum weeks per Semester</td><td>15 (Including Classwork, examination, preparation, holidays etc.)</td></tr>
<tr><td>Effective From</td><td>June 2020</td></tr>
<tr><td>Purpose of Course</td><td>The Immunology course aims to provide an adequate understanding about the fundamentals of the immune system and the students gain knowledge about the features and mechanisms of innate and adaptive immune response. Be able to compare and contrast the innate versus adaptive immune systems</td></tr>
<tr><td>Course Objective</td><td>To make students understand the organization of the immune system and host resistance against an invading organism. to provide students with a foundation in immunological processes</td></tr>
<tr><td>Course Outcomes</td><td>CO1: Explain students the insight of the immune system, physical barriers in non-specific resistance and organs and tissues of the immune system. A description of cells involved in the immune response either innate or acquired.
CO2: Students gain understanding about processes of phagocytosis and inflammation.
CO3: The course also explains the chemical mediators in non-specific resistance like cytokines, complement, acute-phase proteins and antimicrobial peptides.
CO4: To provide an adequate knowledge about antigens, T cell biology, types of specific immunity and recognition of foreignness.
CO5: To gain a deep knowledge about B cell biology, Immunoglobulin structure, function and classes.</td></tr>
<tr><td>Mapping between COs with PSOs</td><td>
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<tr><td>CO3</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO4</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO5</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>Pre-requisite</td><td></td></tr>
</table>

Course Content	

	UNIT 1	INNATE HOST RESISTANCE	
	Reference: 9th Prescott	**Teaching Duration**	**10 Lectures**
1.1	Innate resistance overview		
1.2	Physical and chemical barrier: Defence of innate resistance		
1.3	Chemical mediator in innate resistance		
1.4	Cell tissues and organs of the immune system		
1.5	Phagocytosis		
1.6	Inflammation		

	UNIT 2	ADAPTIVE IMMUNITY	
	Reference: 9th Prescott	**Teaching Duration**	**10 Lectures**
2.1	Overview of Adaptive Immunity		
2.2	Antigen		
2.3	Types of adaptive immunity		
2.4	Recognition of foreignness		
2.5	T-Cell biology		
2.6	B-Cell biology		
2.7	Antibodies and monoclonal antibody		

	UNIT 3	CLINICAL IMMUNOLOGY	
	Reference: 9th Prescott	**Teaching Duration**	**10 Lectures**
3.1	Serotyping		
3.2	Agglutination		
3.3	Complement fixation		
3.4	Immunoblotting, Immunoprecipitant		
3.5	Immunodiffusion, Immunoelectrophoresis		
3.6	Radioimmunoassay		
3.7	ELISA		

	UNIT 4	IMMUNE TOLERANCE AND IMMUNE DISORDERS	
	Reference: 9th Prescott	**Teaching Duration**	**10 Lectures**
4.1	Acquired immune tolerance		
4.2	Immunodeficiency		
4.3	Autoimmunity and Autoimmune diseases		
4.4	Hypersensitivity		

Reference Books	**REFERENCES:** Wiley,J., andSherwood,L. (2014).Prescott,HarleyandKlein'sMicrobiology,9Ed.,McGraw-HillScience/Engineering/Maths. **FurtherReading:** Tortora G. J., Funke B. R. and Case C. L., (1997), Microbiology: An Inroduction, 6th ed.,AddisonWesleyLongmanInc. PommervilleJ.C.,(2014),Alcamo's fundamentalsofmicrobiology, 10thed.,JonesandBartlettlearning Pelczar,ChanandKrieg,(1993),Microbiology-ConceptsandApplication,InternationalEdition,McGraw-Hill
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment

Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

Course Code	**MB15**
Course Title	**MICROBIALPATHOGENICITYANDDISEASES**
Credit	2
Teaching per Week	2
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	June 2020
Purpose of Course	Students acquire the knowledge of different disease and their causative organisms.
Course Objective	Students will able to gain knowledge about pathogenicity, airborne-water borne diseases.
Course Outcomes	CO1: Students are aware of causative agents. CO2: Students can think for preventive measures and medicines in their surroundings.
Mapping between COs with PSOs	
Pre-requisite	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1						
CO2						

Course Content	

	UNIT 1	PATHOGENICITY AND INFECTION	
	Reference: 9th Prescott	**Teaching Duration**	**10 Lectures**
1.1	Pathogenicity and Infectious disease		
1.2	Virulence		
	1.2.1 Pathogenicity islands		
	1.2.2 Virulence factors		
1.3	Exposure andtransmission		

	UNIT 2	AIR BORNE DISEASES	
	Reference: Greenwood	**Teaching Duration**	**10 Lectures**
2.1	Tuberculosis		
2.2	Diptheria		
2.3	Bacterial and Viral Pneumonia		
2.4	Influenza		
2.5	Common Cold		
2.6	Aspergillosis		

	UNIT 3	CONTACT AND VECTOR BORNE DISEASES	
	Reference: Greenwood	**Teaching Duration**	**10 Lectures**
3.1	Staphylococcal Infections		
3.2	Syphilis		
3.3	Leptospirosis		
3.4	AIDS		
3.5	Typhus		
3.6	Plague		
3.7	Malaria		
3.8	Filaria		
3.9	Dengue		

	UNIT 4	FOOD AND WATER BORNE DISEASES	
	Reference: Greenwood and 9th Prescott	**Teaching Duration**	**10 Lectures**
4.1	Gastroentritis – Bacterial and Rota Virus		
4.2	Salmonellosis		
4.3	Typhoid		
4.4	Cholera		
4.5	Bacterial and Amoebic Dysentery		

Reference Books	REFERENCES: Wiley,J.,andSherwood,L.(2014).Prescott,HarleyandKlein'sMicrobiology,9Ed.,McGraw-HillScience/Engineering/Maths. Greenwood.D.,andBlack,R.C.(2012).MedicalMicrobiology,6thEd.,ChurchillLivingstone. **Furtherreading:** Pelczar,ChanandKrieg,(1993),Microbiology-ConceptsandApplication,InternationalEdition,McGraw-Hill. TortoraG.J.,andFunkeB.R.(2016),MicrobiologyanIntroduction, 12thEd.,BenjaminCummings
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation,

	class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

Course Code	**MB-16**
Course Title	**MICROBIOLOGYOFENVIRONMENT**
Credit	2
Teaching per Week	2
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	June 2020
Purpose of Course	Make students aware about presence of organisms in their environment, their plants, in their water and waste and how to handle these organisms in environment.
Course Objective	They learn about basic air water contamination of organism.
Course Outcomes	CO1: They know their environment and try to handle and remove the pathogenic organisms from environment. CO2: They learn about different types of organisms present in environment.
Mapping between COs with PSOs	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1						
CO2						

Pre-requisite	Basic Science	
Course Content		

	UNIT 1	BACTERIOLOGY OF AIR	
	Reference: Salle	**Teaching Duration**	**10 Lectures**
1.1	Introduction		
1.2	Number and kinds of organisms in air		
1.3	Enumeration of bacteria in air		
1.4	Effect of atmospheric temperature and humidity		
1.5	Air sanitation		

	UNIT 2	PLANT PATHOLOGY	
	Reference: Purohit	**Teaching Duration**	**10 Lectures**
2.1	Disease: Definitions		
2.2	Nature of plant diseases and Symptoms		
2.3	Plant and pathogen relationship & proof of pathogenicity		
2.4	Transmission of plant viruses		
2.5	Citrus canker		
2.6	Tobacco mosaic disease		
2.7	Black stem rust of wheat		
2.8	Red rot of sugar cane		

	UNIT 3	**MICROBIOLOGY OF DRINKING WATER AND WASTE WATER TREATMENT**	
	Reference: 9th Prescott	**Teaching Duration**	10 **Lectures**
3.1 3.2	Water Purification and Sanitary analysis of drinking water. Wastewater treatment		

	UNIT 4	**EXTREMOPHILES**	
	Reference: Schaechter, Dubey and Maheshwari	**Teaching Duration**	**10 Lectures**
4.1	Physiology, Molecular adaptations and Applications of Hyperthermophiles Extreme Acidophiles Psychrophiles Barophiles Halophiles Alkaliphiles		
4.2	Applications of Extremozymes in Biotechnology		**(Desk encyclopedia)**

Reference Books	**REFERENCES:** - Wiley,J.,&Sherwood,L. (2014).Prescott, Harley,andKlein'sMicrobiology,9th Ed.,McGraw-HillScience/Engineering/Math.
- Purohit,S.S.,(2006).Microbiology:Fundamentalsand Applications,7th Ed.,Agrobios
- Schaechter.M.,(2004)TheDeskEncyclopediaofMicrobiology,ElsevierAcademicPress.
- Salle, A. J., (1993).Fundamental Principles of Bacteriology, 7th Ed., Tata-McGraw-Hill(ISBN:0-07-099562-1)
- Dubey R.C.and Maheshwari D.K. A textbook of Microbiology. Revised Edition2010.S.Chand&Company.ISBN-81-219-2559-2 **FurtherReading:** - Pelczar, M. J., & Chan, E. C. S. (1998).Microbiology, 5Ed., Tata-McGraw-Hill
- R.M.Maier(2006)Environmentalmicrobiology,Elsevier.
- SoliArceivala&AsolkerShyamR.(2007),Wastewatertreatmentforpollutioncontrol &reuse.3rd Ed.,Tata-McGraw-Hill.
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

<table>
<tr><td>Course Code</td><td>MBP:05</td></tr>
<tr><td>Course Title</td><td>PRACTICALS</td></tr>
<tr><td>Credit</td><td>6</td></tr>
<tr><td>Teaching per Week</td><td>12</td></tr>
<tr><td>Minimum weeks per Semester</td><td>15 (Including Classwork, examination, preparation, holidays etc.)</td></tr>
<tr><td>Effective From</td><td>June 2020</td></tr>
<tr><td>Purpose of Course</td><td>Purpose of the course is to learn the different isolation method for bacteria/fungi, Rapid kit based experiments for malaria and syphilis and estimation process of bimolecular structures like carbohydrate and protein.</td></tr>
<tr><td>Course Objective</td><td>• To understand the morphological characteristicsofyeast/Protozoa by microscopy
• To study the quantitative estimations of protein and sugar.
• To understand the isolation and study of water organisms
• To understand the plant pathogenic bacteria</td></tr>
<tr><td>Course Outcomes</td><td>CO1: Students will learn about isolation, extraction and purification of DNA.
CO2-CO3: Students will learn about basic morphological structure of living cell by dark field as well as phase contrast microscopy.
CO4-CO5: Students will learn about isolation methods for antibiotic resistance as well as pigmented mutants by U.V. rays.
CO6-CO7: students will learn about estimation f sugar and protein.
CO8-CO10: Students will have knowledge about widal, RPR and blood group testing via kit based method.
CO11-CO14: Students will learn isolation of fecal indicator, detection and enumeration method.
CO15-16: Students will learn about isolation of coliphage and pathogenic bacteria.
CO17-CO18: Through permanent slides of pathogenic vector and fungi, students will learn about basic morphological structure.</td></tr>
<tr><td>Mapping between COs with PSOs</td><td>
<table>
<tr><th></th><th>PSO1</th><th>PSO2</th><th>PSO3</th><th>PSO4</th><th>PSO5</th><th>PSO6</th><th>PSO7</th><th>PSO8</th></tr>
<tr><td>CO1</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO2</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO3</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO4</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO5</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO6</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>Pre-requisite</td><td>Basic Science</td></tr>
</table>

Course Content	1. Extractionofgenomic bacterialDNAandseparationbygelelectrophoresis 2. Observationofmorphologicalcharacteristicsoffu ngi/ProtozoabyDarkfieldmicroscopy. 3. Observationofmorphologicalcharacteristicsofyeast/P rotozoabyPhaseContrastmicroscopy. 4. Isolationofantibioticresistantmutantbygradientplatetechnique 5. Isolationofpigmentationmutantsbyultravioletrays 6. Estimationofreducingsugars:Cole'smethod 7. Estimationofprotein: Folin– Lowry'smethod 8. Widaltest–Dreyer'sDoubleDilution 9. RPRtest–Qualitative 10. Determinationofbloodgroups 11. Detectionofcoliforms(Presumptive,Confirmed andCompletedtest) 12. Presence-Absencetestfor sanitaryexaminationofdrinkingwater 13. EnumerationsofColiformbyMPNmethod 14. Isolationoffaecalindicatorbacteria(*Enterococcusfae calis*) bymembranefiltertechniquefromsewage 15. IsolationofColiphagefromSewage. 16. Isolationofplantpathogenicbacteriafromcitruscanker. 17. Studyofplantpathogenicfungi.(Permanentslidesofvariousstageso flifecycleof *Pucciniagraminis*) 18. Studyofpermanentslidesoffourarthropodvectors(*Aedes*and *Anopheles*mosquitoes,Ratflea,Mite)
Reference Books	**REFERENCES:** 1. Patel, R. J.,&Patel, R. K.,(2015).ExperimentalMicrobiology, Vol. 1, 9th ed.,Aditya. 2. Patel, R. J.,&Patel, R. K.,(2015).ExperimentalMicrobiology, Vol. 2, 9th ed.,Aditya. 3. Cappuccino,J.G.,(2005).Microbiology:ALaboratoryManual,6th Ed.,PearsonEducation(Singapore)Pte.Ltd. 4. Aneja, K.R., (2003). Experiments in Microbiology 4th ed., Experiments in microbiology,PlantPathology,TissueCultureandMushroomPro ductionTechnology,NewAgeInternationalPublishers
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

B.Sc. 6 Semester

MB:17FOODAND DAIRYMICROBIOLOGY

<table>
<tr><td>Course Code</td><td>MB:17</td></tr>
<tr><td>Course Title</td><td>FOODAND DAIRYMICROBIOLOGY</td></tr>
<tr><td>Credit</td><td>2</td></tr>
<tr><td>Teaching per Week</td><td>2</td></tr>
<tr><td>Minimum weeks per Semester</td><td>15 (Including Classwork, examination, preparation, holidays etc.)</td></tr>
<tr><td>Effective From</td><td>2020- 2021</td></tr>
<tr><td>Purpose of Course</td><td>Purpose of the course is to make the students able to understand the relationship of food with microorganisms and also make them able to understand how orga are advantagious for human</td></tr>
<tr><td>Course Objective</td><td>Students learn about various organisms involved in food and dairy technology.
Students will Learn about food storage , spoilage and fermented food.</td></tr>
<tr><td>Course Outcomes</td><td>CO 1: Students come out with the knowledge of food and dairy industry
CO2: To understand the relationship of organisms with food and its uses in human</td></tr>
<tr><td>Mapping between COs with PSOs</td><td>
<table>
<tr><td></td><td>PSO1</td><td>PSO2</td><td>PSO3</td><td>PSO4</td><td>PSO5</td><td>PSO6</td></tr>
<tr><td>CO1</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO2</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>Pre-requisite</td><td>Basic Science</td></tr>
</table>

Course Content

	UNIT 1	INTRODUCTION TO FOOD MICROBIOLOGY	
	Reference: 4th Frazier	Teaching Duration:	10 Lectures
1.1	Food as a substrate for microorganisms		
1.2	Principles of food preservation:		
	1.2.1 Asepsis		
	1.2.2 Removal of microorganisms		
	1.2.3 Heat treatments employed in processing foods		
	1.2.4 Temperatures employed in low-temperature storage		
	1.2.5 Methods of drying		
	1.2.6 Added preservatives		
	1.2.7 Developed preservatives		
	1.2.8 Preservation by radiation		

	UNIT 2	FOOD SPOILAGE	
	Reference: 4th Frazier	Teaching Duration:	10 Lectures
2.1	Contamination and Spoilage of food:		
	2.1.1 Bread		
	2.1.2 Vegetables and fruits		
	2.1.3 Heated canned foods		
2.2	Food borne diseases		(Prescott)
2.3	Detection of food-borne pathogens		(Prescott)
2.4	The HACCP System and Food safety : Outline		(James Jay)

	UNIT 3	DAIRY MICROBIOLOGY	
	Reference: Sukumar De	Teaching Duration:	10 Lectures
3.1	Definition		
3.2	Indian standards		
3.3	Composition and nutritive value of milk		
3.4	Contamination and Spoilage of milk and milk products		(Frazier)
3.5	Preservation of milk and milk products		(Frazier)
3.6	Fermented milks		(Prescott)
3.7	Cheese production		(Prescott)
3.8	Probiotics		(Prescott)

	UNIT 4	MICROORGANISMS AS FOOD AND FERMENTED FOODS	
	Reference: 9th Prescott	Teaching Duration:	10 Lectures
4.1	Single cell protein		(Purohit)
4.2	Mushroom Culture		(R.C.Dubey)
4.3	Listoffermented foods		
4.4	Productionofalcoholicbeverages		
4.5	Pro ductionofbreads		

Reference Books

REFERENCES:

- Frazier,W.C.andWesthoff,D.C.,(2006).FoodMicrobiology,4Ed., TataMc-GrawHill,India.
- Sukumar De.(2013).OutlinesofDairyTechnology,Oxforduniversity.(ISBN:978-0-19561194-6
- Wiley,J.,&Sherwood,L.(2007).Prescott,Harley,and Klein'sMicrobiology,9Ed.,McGraw-HillScience/Engineering/Math.
- Dubey,R.C. (2010).TextbookofBiotechnology,S. Chand.Multicolor1Ed.
- James M. Jay (2000) Modern

	Food Microbiology.Sixth editionAN ASPEN PUBLICATION® Aspen Publishers, Inc.Gaithersburg,Maryland. **FurtherReading:** • Purohit, S.S.,(2006). *Microbiology*:*FundamentalsandApplications*,7Ed.,Agrobios(India). • Pelczar, M. J.,&Chan, E.C.S.(1998).*Microbiology*,5Ed.,Tata-McGraw-Hill.
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

MB:18PRINCIPLESOFFERMENTATIONTECHNOLOGY

Course Code	**MB:18**
Course Title	**PRINCIPLESOFFERMENTATIONTECHNOLOGY**
Credit	2
Teaching per Week	2
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	2020 -2021
Purpose of Course	Make students learn to know about the principles of fermentation technologies.
Course Objective	Students learn about fermentation process and also learn about fermenter uses in industries.
Course Outcomes	CO1:Students come out with sound knowledge of fermentation in industries with designing of fermenters which make them compete for their job at industries. CO2:Students will learn about basic downstream process for product extraction.

Mapping between COs with PSOs	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1						
CO2						

Pre-requisite	Basic Science

Course Content

	UNIT 1	HISTORY AND BASIS FOR THE DEVELOPMENT OF THE FERMENTATION PROCESSES	
	Reference: A. H. Patel	**Teaching Duration:**	**10 Lectures**
1.1	Historical developments in fermentation technology		
1.2	Screening for new metabolites		(Cruger)
1.3	Screening techniques: Primary and secondary screening		
1.4	Fermentation Processes		(Cruger)
1.5	Fermentation media		(Waites)

	UNIT 2	STRAIN DEVELOPMENT	
	Reference: Creuger	**Teaching Duration:**	**10 Lectures**
2.1	General aspects		
2.2	Mutations		
2.3	Selection of mutants		
2.4	Recombination		
2.5	Regulation		
2.6	Gene technology		
2.7	Use of genetic methods		

	UNIT 3	DESIGN OF FERMENTOR AND INDUSTRIAL STERILIZATION	
	Reference: Stanbury	**Teaching Duration:**	**10 Lectures**
3.1	Introduction		
3.2	Aseptic operation		
3.3	Body construction		
3.4	Temperature control		
3.5	Aeration and agitation		
3.6	Maintenance of aseptic condition		
3.7	Monitoring and control of various parameters		
3.8	Types of fermentors		

	UNIT4	**DOWNSTREAMPROCESSESING**
	Reference:Waites	**TeachingDuration:10 Lectures**
4.1	IntroductionCell	
4.2	harvestingCelldi	
4.3	sruption	
4.4	Product recovery	
4.5	Finishingstep	

Reference Books

- Patel,A.H.,(2012).IndustrialMicrobiology,2Ed.Macmillan,India.
- Stanbury,P.F.,(2006).PrinciplesofFermentationTechnology,2Ed.,ElsevierScience Ltd.
- Creuger,W.,(2005).Biotechnology:Atextbookofindustrialmicrobiology,2Ed.,Panima,NewDelhi.
- Waites, M.J., et al., (2001), Industrial microbiology: An

	Introduction,1st ed., Blackwellpublishing **FurtherReading:** • SivakumaarP.K.,JoeM.M.andSukeshK.,(2010),Anintroductiontoindustrialmicrobiology,1sted.,S.Chandpublication • SrivastvaM.L., (2008),Fermentationtechnology, 1sted.,Narosapub. house
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

MB19:ECONOMICMICROBIOLOGY

Course Code	**MB19**
Course Title	ECONOMICMICROBIOLOGY
Credit	2
Teaching per Week	2
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	2020 – 2021
Purpose of Course	Students know about hoe the organisms can be utilize for the production of different enzymes, antibiotics and how it can be used in various field.
Course Objective	They learn about fermentation process and learn about use of organisms in Agriculture in fuel field and in remediation.
Course Outcomes	CO1: Students are able to join industries where microorganisms are utilized for enzymes, antibiotic or fuel production. CO2: Students will learn about basic techniques related to bioremediation and bioleaching.
Mapping between COs with PSOs	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1						
CO2						

Pre-requisite	Basic Science
Course Content	

	UNIT 1	TYPICAL FERMENTATION PROCESSES	
	Reference: Cruger	**Teaching Duration**	**10 Lectures**
1.1	L-Glutamic acid		
1.2	Acetic acid		
1.3	Acetone/Butanol Fermentation		
1.4	Amylases		
1.5	Penicillins		
1.6	Riboflavin		

	UNIT 2	AGRICULTURAL MICROBIOLOGY AND ENZYME TECHNOLOGY	
	Reference: Dubey	**Teaching Duration**	**10 Lectures**
2.1	Biosensor		
2.2	Extracellular Polysaccharides		**(Cruger)**
2.3	Biofertilizers: Bacterial Innoculants		
	2.3.1 Rhizobium		
	2.3.2 Azobacter		
	2.3.3 Phosphate Solubilizer		
2.4	Bacterial Insecticides (Production and Formulation)		**(A. H. Patel)**
2.5	Stabilization of Enzymes by means of Immobilization		**(Cruger)**

	UNIT 3	BIO ENERGY	
	Reference: Dubey	**Teaching Duration**	**10 Lectures**
3.1	Gaseous Fuels: Biogas and Hydrogen		
3.2	Alcohols: The Liquid Fuel		
3.3	Recovery of Petroleum		**(Bartha)**

	UNIT 4	MICROBIAL LEACHING AND BIOREMEDIATION	
	Reference: Dubey	**Teaching Duration**	**10 Lectures**
4.1	Leaching		**(Cruger)**
4.2	Bioremediation: General Aspects		
4.3	Bioremediation of Hydrocarbons		
4.4	Bioremediation of Xenobiotics		
4.5	Bioremediation of Industrial Wastes		

Reference Books	**REFERENCES:** Cruger,W.(2005)Biotechnology:AtextbookofIndustrialMicrobiology,2 Ed.Panima,NewDelhi Dubey, R.C.(2010)TextbookofBiotechnology,S. Chand,Multicolor 1Ed. Patel,A.H.(2012) IndustrialMicrobiology. 2Ed.Macmillan, India. Atlas,R.M.andBartha,R.(1998)MicrobialEcology,4Ed. **FurtherReading:** SivakumaarP.K.,JoeM.M.andSukeshK.,(2010),Anintroductiontoindustrialmicrobiology,1st ed.,S.Chandpublication SrivastvaM.L., (2008),Fermentationtechnology, 1st ed.,Narosapub. house
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation,

	class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

MB20:BIOINFORMATICS

Course Code	**MB20**
Course Title	**BIOINFORMATICS**
Credit	2
Teaching per Week	2
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	2020 – 2021
Purpose of Course	To make the students aware about coputer techniques and uses for structure prediction and phylogenecity
Course Objective	Students learn about different types of databases To study the bioinformatics tools for structural prediction and phylogenecity
Course Outcomes	CO 1: students having knowledge of databases CO 2: learn bioinformatics tools and its use in future purpose.
Mapping between COs with PSOs	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1						
CO2						

Pre-requisite	Basic Science

Course Content

	UNIT 1	MICROBIAL GENOMICS AND PROTEOMICS	
	Reference: 9th Prescott	**Teaching Duration:**	**10 Lectures**
1.1	Determining DNA Sequences		
1.2	Whole Genome Shotgun Sequencing		
1.3	Single Cell Genomic Sequence		
1.4	Functional genomics		
1.5	Proteomics		
1.6	Comparative genomics		

	UNIT 2	DATABASES IN BIOINFORMATICS	
	Reference: Orpita Bosu	**Teaching Duration:**	**10 Lectures**
2.1	Introduction to bioinformatics		
2.2	Applications and research in bioinformatics		
2.3	Present bioinformatics scenario		
2.4	Characteristics of bioinformatics database		
2.5	Categories of bioinformatics database - Types of data		
2.6	Sequence database Nucleotide – EMBL Protein – DDBJ		
2.7	Structural database – PDB, CATH		
2.8	Other database – Enzyme database		

	UNIT 3	BIOALGORITHMS AND TOOLS	
	Reference: Ghosh	**Teaching Duration:**	**10 Lectures**
3.1	Introduction And Concepts of Alignment (except gap penalty) (Ghosh)		
3.2	Introduction to scoring matrices		
3.3	Pairwise Alignment (only methods – Global And Local		
3.4	Multiple Sequence Alignment		

	UNIT 4	STRUCTURE PREDICTION AND PHYLOGENETICS	
	Reference: Xiong	**Teaching Duration:**	**10 Lectures**
4.1	Molecular evolution and molecular phylogenetics		
4.2	Terminology		
4.3	Forms of tree representation		
4.4	Phylogenetic tree evaluation		

Reference Books

- WilleyJ.,SherwoodI.,(2011),Prescott,HarleyandKleins Microbiology, 8thed.,McGraw –Hillscience.
- Xiong, J.,(2009). Essential Bioinformatics , Cambridge Universitypr
- GhoshZ.andMallickB.,(2009),Bioinformatics:PrinciplesandApplicat ns,OxfordUniversitypress
- OrpitaBosuandThukralS.K.,(2008),Bioinformatics :Databases,ToolsandAlgorithms.Oxforduniversit yPress.(ISBN:978-0-19-567683-9)

FurtherReading:

- PrimroseS. andTwymanR. (2006).PrinciplesofGeneManipulation&Genomics, 7thedition.BlackwellPublishing,Malden.

Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

MB21:CLINICALMICROBIOLOGY

Course Code	**MB21**
Course Title	**CLINICALMICROBIOLOGY**
Credit	2
Teaching per Week	2
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	2020 – 2021
Purpose of Course	Make students aware about how to handle various clinical samples they are also learn about basic health care system and basic chemotherapy for bacterial and viral disease.
Course Objective	They know basic study about healthcare. They learn about handling and examination of samples in laboratories. They also know basic chemotherapy for bacterial and viral disease
Course Outcomes	CO 1: Students are sound in their clinical microbiology knowledge which help them in their health care. CO 2: Student learn about pathogenecity of urine, semen and fecal specimen
Mapping between COs with PSOs	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1						
CO2						

Pre-requisite	Basic Science

Course Content

	UNIT 1	EPIDEMIOLOGY AND PUBLIC HEALTH MICROBIOLOGY	
	Reference: 9th Prescott	Teaching Duration:	Lectures
1.1	Epidemiology		
1.2	Epidemiological Methods		
1.3	Measuring infectious Disease frequency		
1.4	Patterns of infectious disease in a population		
1.5	Emerging and re-emerging infectious diseases and pathways		
1.6	Health-care associated infections		
1.7	Prevention and control of epidemics		
1.8	Bioterrorism preparedness		

		UNIT 2	CLINICAL MICROBIOLOGY-I	
		Reference: Cheesebrough	**Teaching Duration:**	**Lectures**
2.1	Possible pathogens, collection, transport and laboratory examination of... Sputum Throat and mouth specimen CSF Blood			

		UNIT 3	CLINICAL MICROBIOLOGY-II	
		Reference: Cheesebrough	**Teaching Duration:**	**Lectures**
3.1	Possible pathogens, collection, transport and laboratory examination of. Pus Semen Urine Faecal Specimens			

		UNIT 4	ANTIMICROBIAL CHEMOTHERAPY	
		Reference: 9th Prescott	**Teaching Duration:**	**Lectures**
4.1	Development of Chemotherapy			
4.2	General Characteristics of antimicrobial drugs			
4.3	Determining the level of antimicrobial activity			
4.4	Antibacterial drugs			
4.5	Antifungal drugs			
4.6	Antiviral drugs			
4.7	Antiprotozoan drugs			
4.8	Factors affecting antimicrobial drug effectiveness			

Reference Books	Wiley,J.,&Sherwood,L.,(2007).Prescott,Harley,andKlein'sMicrobiology,9Ed.,McGraw-HillScience/Engineering/Math. Cheesbrough,M.,(2005).District laboratorypracticeintropicalcountriesPart1&2,CambridgeUniversitypress. Pelczar,M.J.,&Chan,E.C.S.(1998).Microbiology,5Ed., Tata-McGraw-Hill.Bauman,R.,(2004).Microbiology,Pearson. MukherjeeK.L., (1988). MedicalLaboratoryTechnology,Vol1,2 &3,TataMcGrawHillPublishing. OcheiJ. andKolhatkar A., (2000).MedicalLaboratoryScience –Theoryand Practice,TataMcGrawHill. GodkarP.B.,(2003).TextbookofMedicalLaboratoryTechnology,2Ed.,BhalaniPublishingHouse
Teaching Methodology	Class work, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

MB22: HAEMATOLOGY

<table>
<tr><td>Course Code</td><td>MB22</td></tr>
<tr><td>Course Title</td><td>HAEMATOLOGY</td></tr>
<tr><td>Credit</td><td>2</td></tr>
<tr><td>Teaching per Week</td><td>2</td></tr>
<tr><td>Minimum weeks per Semester</td><td>15 (Including Classwork, examination, preparation, holidays etc.)</td></tr>
<tr><td>Effective From</td><td>June 2020</td></tr>
<tr><td>Purpose of Course</td><td>Students learn about basic biology of blood with its different properties and various methods for detection of blood grouping and blood banking</td></tr>
<tr><td>Course Objective</td><td>Students come to know basics of blood banking and practical skills of Haematology.</td></tr>
<tr><td>Course Outcomes</td><td>CO 1: Students are having knowledge of blood banking and they have an opportunity to get job in the centre like Medical Laboratory.
CO 2: to learn about blood donor and recipient fiesiability</td></tr>
<tr><td>Mapping between COs with PSOs</td><td>
<table>
<tr><td></td><td>PSO1</td><td>PSO2</td><td>PSO3</td><td>PSO4</td><td>PSO5</td><td>PSO6</td></tr>
<tr><td>CO1</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO2</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
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<tr><td>Pre-requisite</td><td>12th Science with Biology Subject</td></tr>
</table>

Course Content

	UNIT 1	INTRODUCTION TO HAEMATOLOGY	
	Reference: Mukherjee	**Teaching Duration:**	**10 Lectures**
1.1	Blood: Defination and functions		
1.2	Components of blood and their function		
1.3	Haemopoietic system of the body		
1.4	Collection and processing of blood		**(Ochei)**
1.5	Use and types of anticoagulants		**(Godkar)**
1.6	haemostasis and mechanism of blood coagulation		
1.7	Anaemia, leukmia and polycythaemia vera		

	UNIT 2	PRACTICAL HAEMATOLOGY	
	Reference: Mukherjee	**Teaching Duration:**	**10 Lectures**
2.1	Determination of haemoglobin concentration		
	2.1.1 Cyanmethaemoglobin method		
2.2	Determination of haematocrit - PCV		
2.3	Enumeration of formed elements		**(Ochei)**
2.4	Laboratory investigations of bleeding disorders		
	2.4.1 Bleeding time-Ivy method		
	2.4.2 Whole blood clotting time-Lee and White method		
	2.4.3 Prothrombin time		

	UNIT 3	IMMUNOHAEMATOLOGY	
	Reference: Ochei	**Teaching Duration:**	**10 Lectures**
3.1	Blood group antigens and antibodies		
3.2	ABO blood grouping system		
3.3	ABO grouping		
3.4	ABO grouping methods		
3.5	Rh grouping system		
3.6	Methods for Rh typing		

	UNIT 4	BLOOD BANKING	
	Reference: Mukherjee	**Teaching Duration:**	**10 Lectures**
4.1	Selection of blood donor		
4.2	Methods of blood collection –preparation of blood drawing		
4.3	Adverse reaction of donor		
4.4	Preparation and use of blood components		
4.5	Basic laboratory tests-Cross matching		

Reference Books

- MukherjeeK.L.,(1988).MedicalLaboratoryTechnology,Vol1,2 &3,TataMcGrawHillPublishing.
- OcheiJ.and Kolhatkar A., (2000).MedicalLaboratoryScience–TheoryandPractice,TataMcGrawHill.
- GodkarP.B.,(2003).TextbookofMedicalLaboratoryTechnology,2Ed.,BhalaniPublishingHouse

FurtherReading:

- Professionalguidetodiagnostictests,(2004),1st ed.Lippincott Williams&Wilkins(noauthor)

Teaching Methodology	Class work, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

PRACTICALS

Course Code	**MBP06**
Course Title	Practicals
Credit	6
Teaching per Week	12
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	2020- 2021
Purpose of Course	Students learn about Food and Dairy Microbiology, Fermentation process, Economic Microbiology, Clinical Microbiology and Haematology.
Course Objective	Microbiology is practical based course so main objective of this course is to acquaint students about how to isolate, enrich and observe bacteria by learning basic fundamental techniques
Course Outcomes	CO1-CO4: Students will learn about Bacteriologicalinvestigationofdiagnosticproblemsrelatedtoblood, urine, stool, purulentexudates,wound and abscess. CO5-CO8:Students will able to Determine the activityofAntibioticSusceptibility, MIC of antibiotic and bacteriological analysis of milk and food. CO9-CO11: Students will able to learn about fermentative product and bioassay of enzyme. CO12-CO15: Students will able to know about total count of RBC and WBC as well as hemoglobin count including differential count of leucocytes. CO16: Students will able to learn about separation of amino acid by chromatography method. CO17: Students will able to learn about Physical,chemicalandmicroscopicexaminationofurine.
Mapping between COs with PSOs	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1								

	CO2 ■ ■ ■ CO3 ■ ■ ■ ■ CO4 ■ ■ ■ ■ CO5 ■ ■ ■ ■ ■ CO6 ■ ■ ■ ■ ■
Pre-requisite	Basic Science
Course Content	1. Bacteriologicalinvestigationofdiagnosticproblemsrelatedtoblood 2. Bacteriologicalinvestigationofdiagnosticproblemsrelatedto urine 3. Bacteriologicalinvestigationofdiagnosticproblemsrelatedtostool 4. Bacteriologicalinvestigationofdiagnosticproblemsrelatedtopurulentexudates,wound,abscess 5. DeterminationofAntibioticSusceptibility:AgarDiscMethod 6. DeterminationofMICofantibiotic 7. Bacteriologicalanalysisoffood. 8. Bacteriologicalanalysisofmilk(MBRT,qualitative,quantitative,AFB) 9. Sterilitytesting 10. Fermentativeproductionofamylaseanditsestimation 11. Bioassayofpenicillin 12. TotalcountofRBC 13. TotalcountofWBC 14. HaemoglobinestimationbySahli's method 15. DifferentialcountofLeucocytes 16. Seperationofaminoacidsbypaperchromatography 17. Physical,chemicalandmicroscopicexaminationofurine
Reference Books	**REFERENCES:** 1. Patel, R. J.,&Patel, R. K.,(2015).ExperimentalMicrobiology, Vol. 1, 9th ed.,Aditya. 2. Patel, R. J.,&Patel, R. K.,(2015).ExperimentalMicrobiology, Vol. 2, 9th ed.,Aditya. 3. Cappuccino,J.G.,(2005).Microbiology:ALaboratoryManual,6th Ed.,PearsonEducation(Singapore)Pte.Ltd. 4. Aneja, K.R., (2003). Experiments in Microbiology 4th ed., Experiments in microbiology,PlantPathology,TissueCultureandMushroomProductionTechnology,NewAgeInternationalPublishers
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
	30% Internal assessment based on class attendance, participation,

Evaluation Method	class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination